INDEXED.

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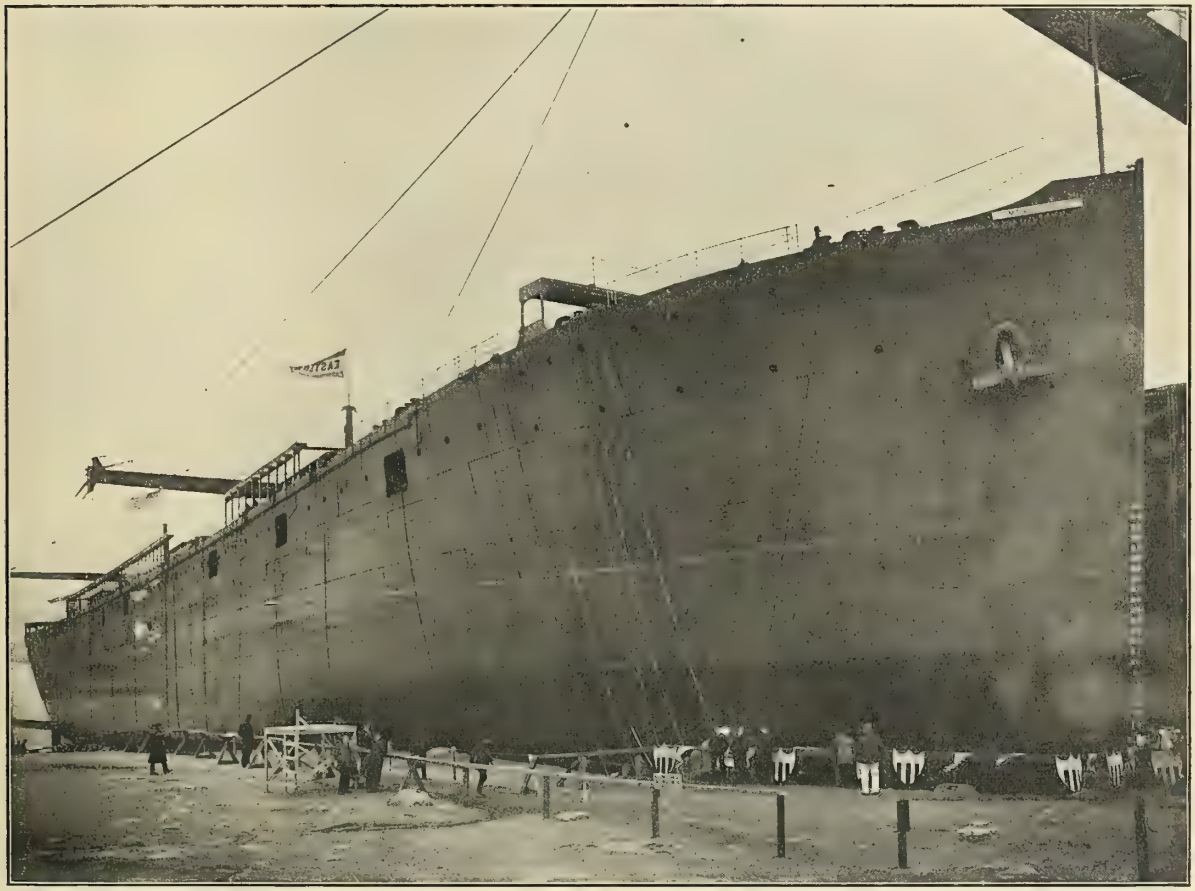
STEAMSHIP MINNESOTA, OF THE GREAT NORTHERN STEAMSHIP COMPANY, BUILT BY THE EASTERN SHIP-BUILDING COMPANY.

The Eastern Shipbuilding Company, of New London, Conn., launched on April 16, from its new yard on the Thames river, the first of the two great vessels it has been building for the Great Northern Steamship Company. As the ship started down the ways she was christened the *Minnesota* by Miss Clara Hill, daughter of Mr. James J. Hill. The launch in every respect was most successful, as a result of very careful arrangement of the construction of the ways, and all details incident to moving such a great bulk of steel as entered into the construction of this ship, and was made a memorable occasion from the presence of many distinguished men in shipping, railroad, and financial circles.

The yards of the Eastern Shipbuilding Company were fully described in the March (1902) issue of MARINE ENGINEERING, and suffice it to say that as laid out by the president, Mr. Charles R. Hanscom, have fully met the exceptional requirements.

When the contracts were signed for the two great ships now under construction, not only was it necessary to design and construct these vessels, but also to lay out and build a shipyard. The experience of Mr. Hanscom, who comes from a family of shipbuilders, and who was brought up from the technical school through the different departments of the shipyard to succeeding positions of responsibility, qualified him to undertake this work, a measure of the success of which may be judged from the present condition of these mammoth ships.



STEAMSHIP MINNESOTA BEFORE LAUNCHING FROM THE YARD OF THE EASTERN SHIPBUILDING COMPANY.
[Photographed specially for Marine Engineering by Enrique Müller.]

HULL CONSTRUCTION.

The *Minnesota*, and the *Dakota* soon to be launched, are intended to run between Seattle and Japanese and

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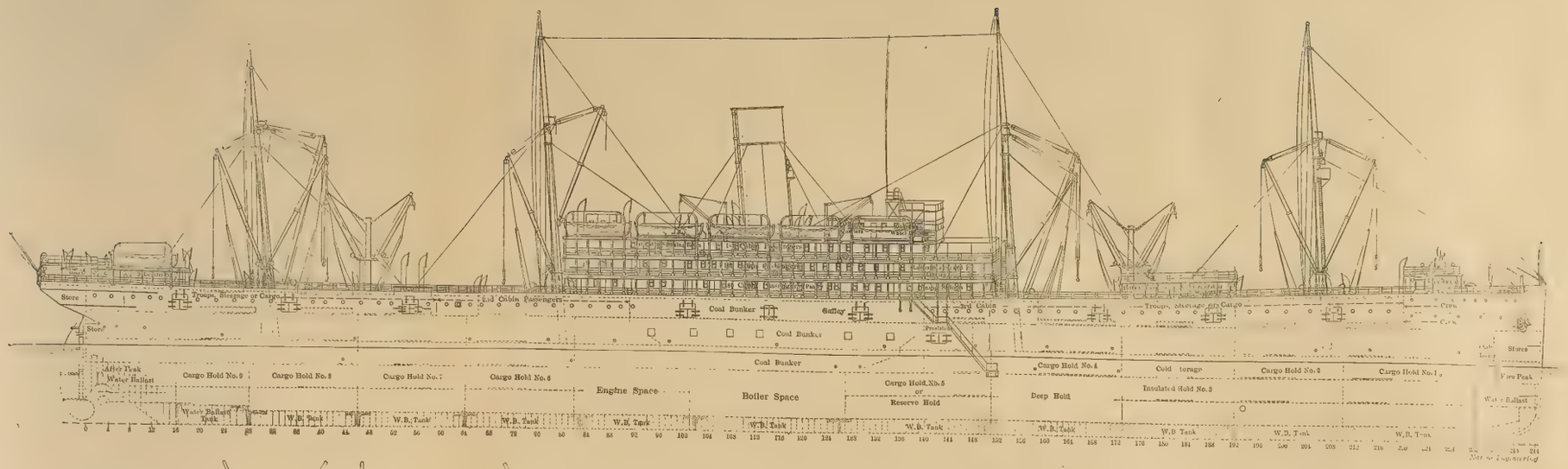
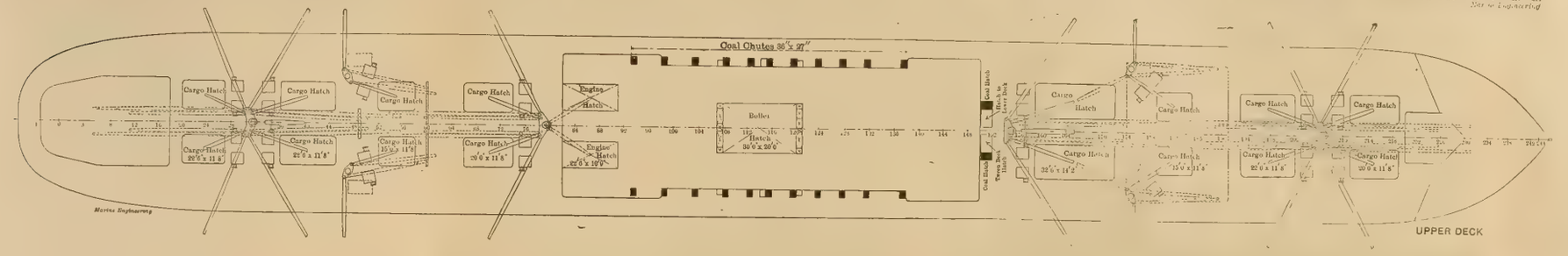
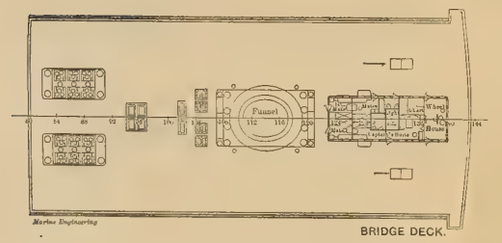
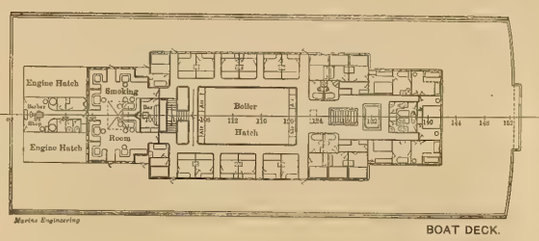




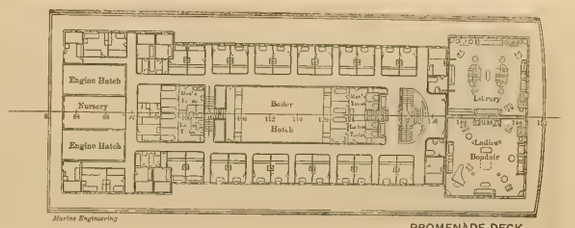
UPPER DECK



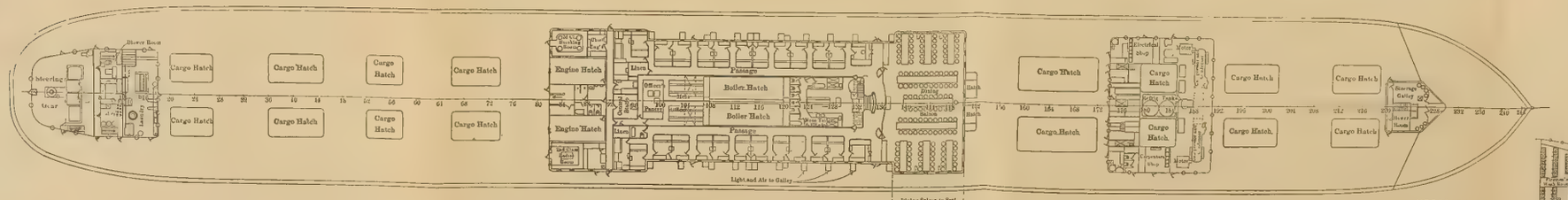
BRIDGE DECK.



BOAT DECK.



PROMENADE DECK.



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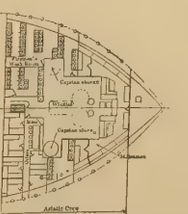
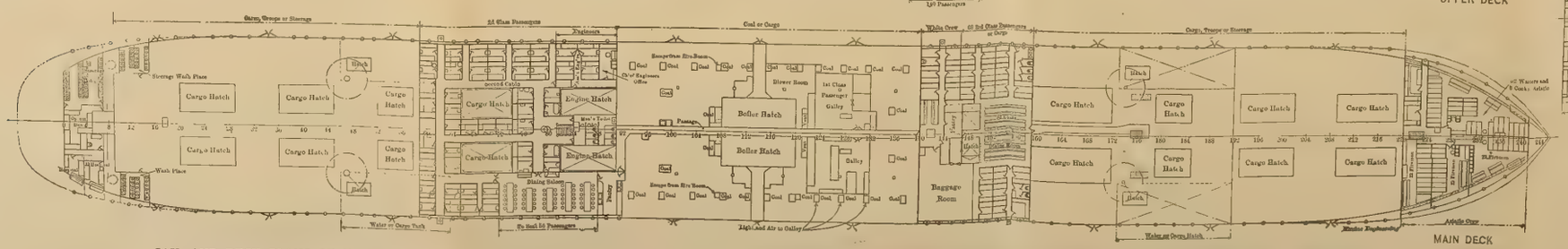


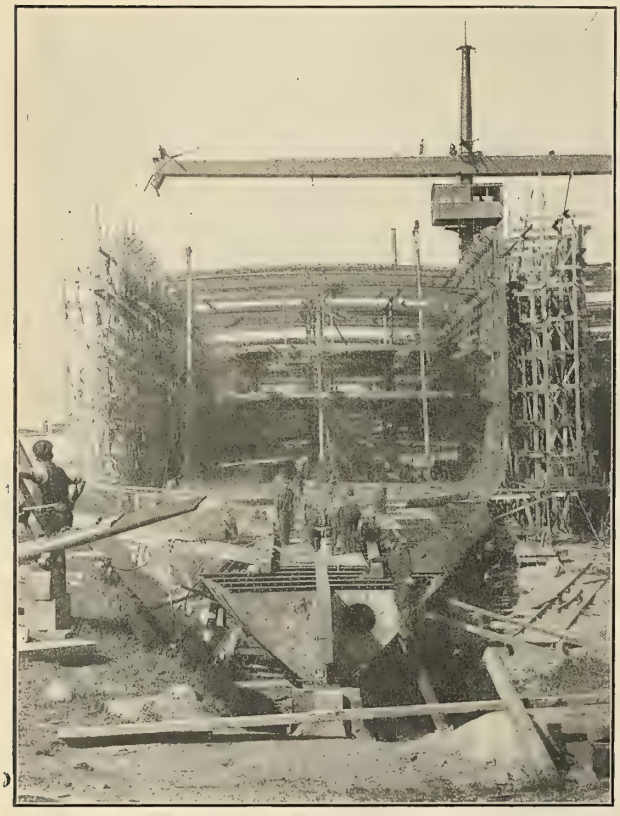
FORECASTLE DECK
BETWEEN MAIN AND UPPER DECK

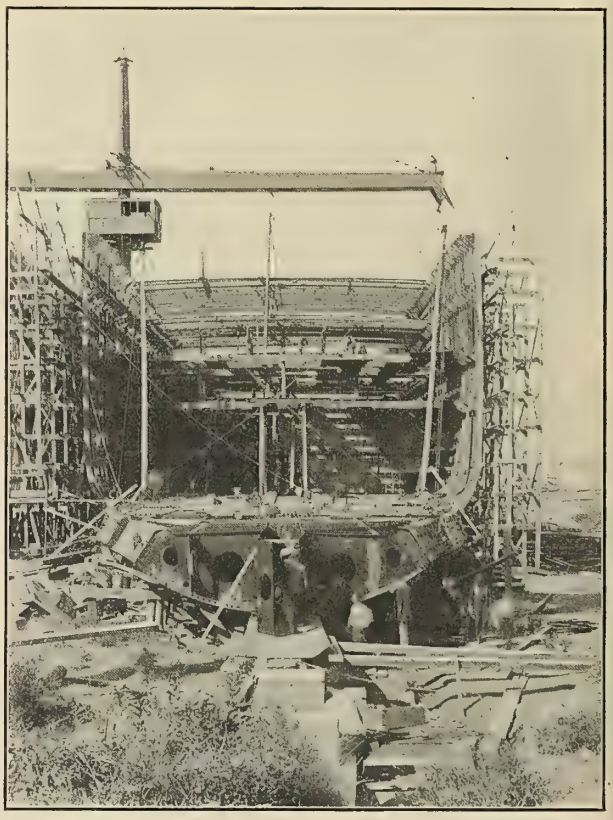


MAIN DECK

SAIL AND DECK PLANS OF THE STEAMSHIPS MINNESOTA AND DAKOTA, BUILT BY THE EASTERN SHIPBUILDING COMPANY, NEW LONDON, CONN., FOR THE GREAT NORTHERN STEAMSHIP COMPANY.

Chinese ports. They are the largest ever built in America, no other vessels touching them in size by several thousand tons. They are not remarkable as far as speed is concerned, being of the intermediate cargo and passenger type, but their passenger accommodations will compare most favorably with the largest Atlantic liners, and in freight-carrying capacity and displacement far exceed any vessel built in America. The vessels are 630 feet length over all and 73 feet 6 inches extreme beam. There are five complete decks in the hull proper and three decks in the superstructure or main house, and the nomenclature for these is, orlop, lower, 'tween, main, and upper which is the weather deck; and in the deck house are the promenade, bridge, and boat decks, with the navigating bridge above all. A double water bottom, 6 feet deep at the center line and 4 feet at the margin, extends from the forward to the after collision bulkheads, and twelve transverse bulkheads extend from side to side, six to the main deck and six to the upper deck. There is also a water-tight center-line bulkhead extending the entire length of the ship, fore and aft, running to the main deck. The plating of all bulkheads runs from 12 to 18 pounds, and is stiffened by 8 by 31 by .41-inch bulb angles.



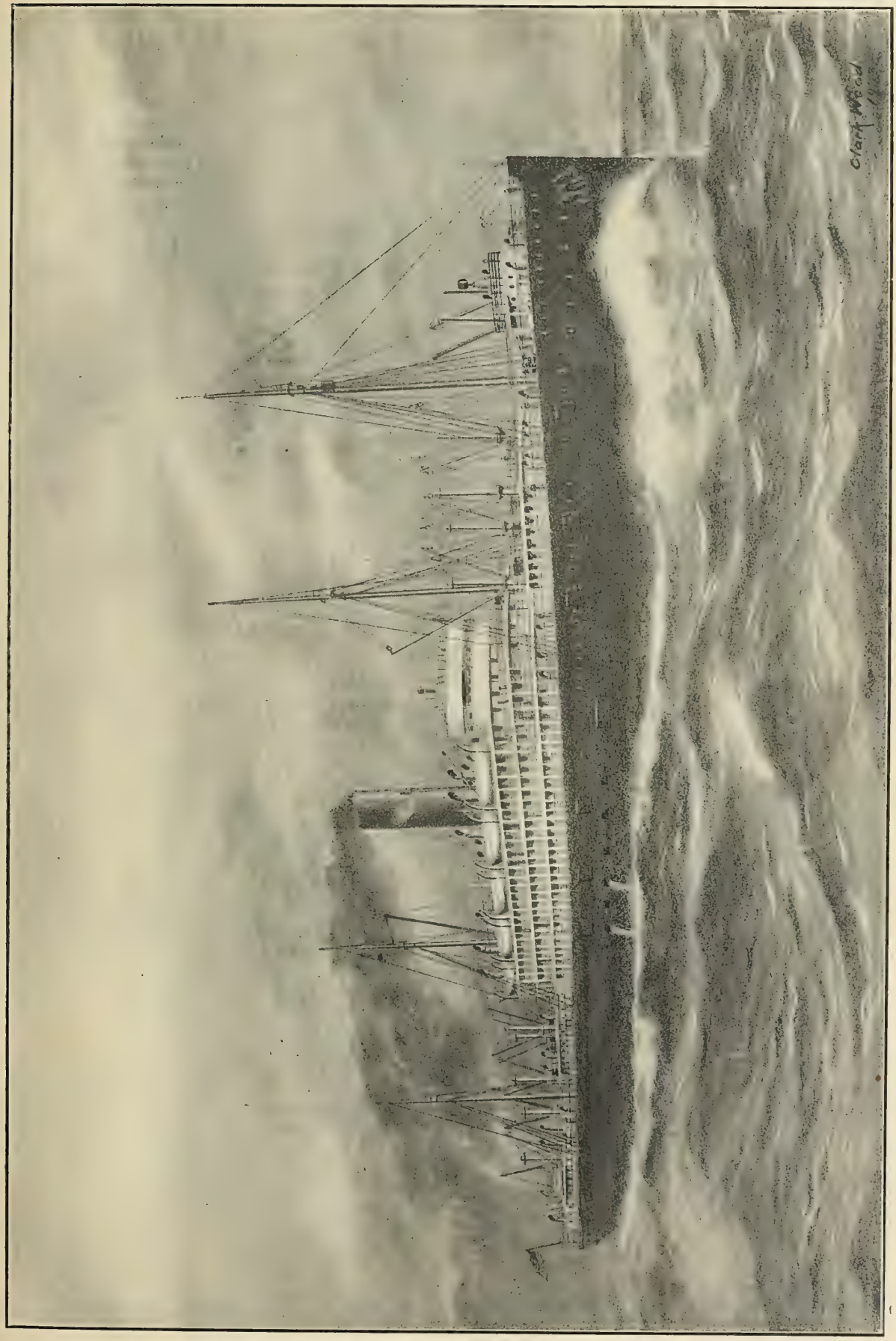


BOW VIEWS OF THE TWO GREAT SHIPS AT NEW LONDON DURING CONSTRUCTION, SHOWING OVERHEAD TROLLEY SYSTEM.

There are several special features of construction, made necessary in a ship of these great dimensions. There are two vertical center keelsons, running the entire length, fore and aft, excepting at the extreme ends, where they run into one at the center line. In the water bottom the longitudinals are continuous and the floors intercostal. Extending from the forward boiler room bulkhead to No. 1 hatch, or a distance of 207 feet, is a pipe tunnel and emergency drain 9 feet high, built as shown in the midship section. One side of this tunnel is a continuation of one of the center keelsons, and on top of this extends the center-line bulkhead, which, as will be seen, is 18 inches off the true center line. Under the floor of the tunnel is the emergency drain, which is connected by valves to each of the forward compartments, and the valves may be operated from either the tunnel or the upper deck; thus, if any compartment is pierced, connection may be made by this drain to the pumps in the engine room and the water discharged at the rate of 25,000 gallons per minute. There is also means of escape from the tunnel at the forward end to the main deck. The piping to the compartments aft the engine room is laid through the shaft alleys, and a similar emergency drain fitted in each shaft alley.

The ships are classified for Lloyds' highest rating, and some of the principal scantlings are as follows:

Inner keel plate, 59 inches wide by 50 pounds; outer keel plate, 16 inches wide by 80 pounds; the frames amidships are 12 by 3 by 3 11-16 by 9-16-inch channels, split at the lower end, one half extending to the bottom of the margin plate and attached to the shell plating, and the other half being curved to the tank top as a reverse frame. At the ends there are frames and reverse frames, the former being 8 by 3 1-2 by 10-20 inch angles, and the latter 7 by 3 1-2 by 10-20 inch angles. All frames run to the upper deck; the spacing amidships is 30 inches



PASSENGER AND FREIGHT STEAMSHIP MINNESOTA, FOR ORIENTAL TRADE, WHICH THE EASTERN SHIPBUILDING COMPANY, NEW LONDON, CONN., IS COMPLETING FOR THE GREAT NORTHERN STEAMSHIP COMPANY.

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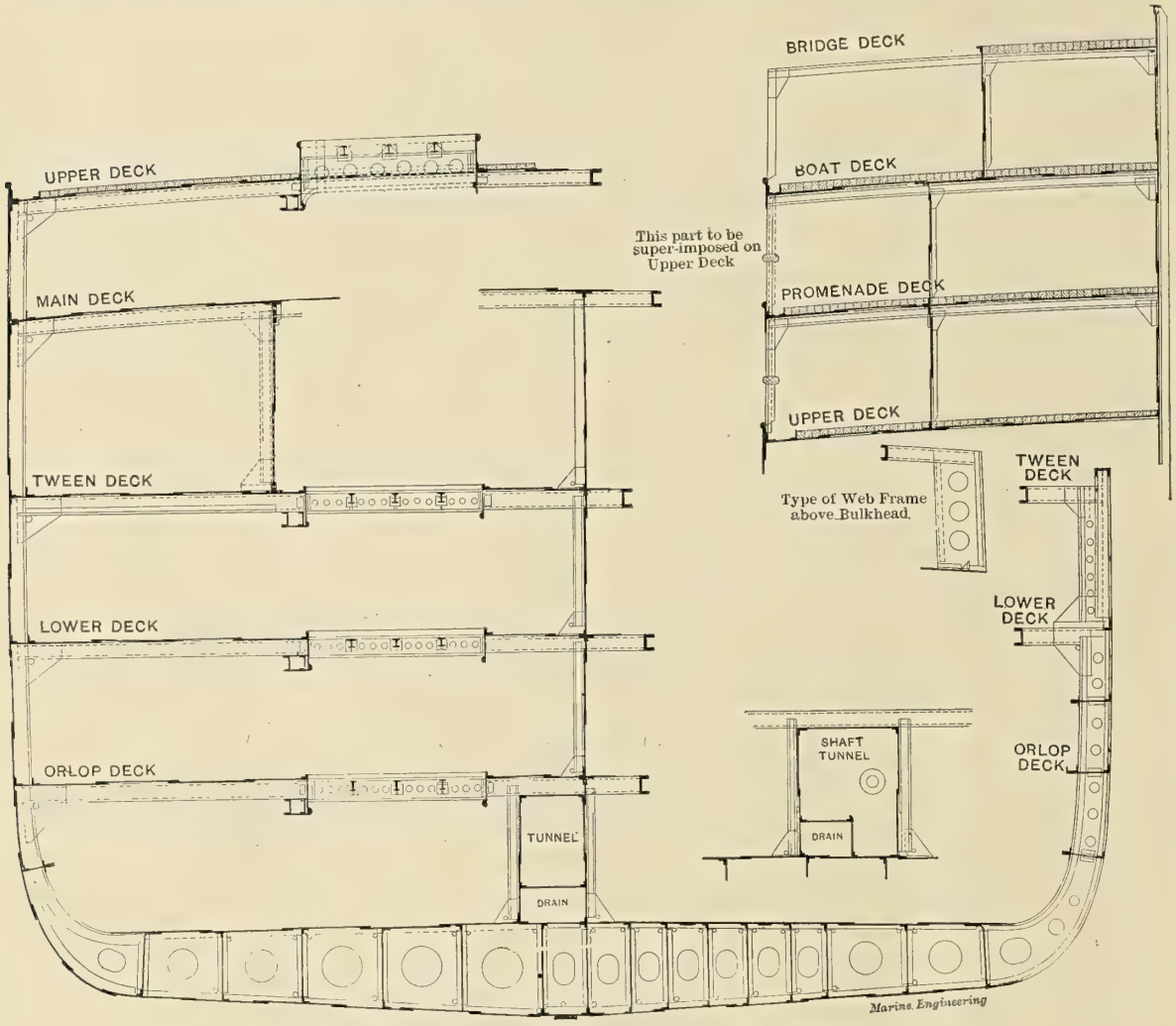
and at the ends 27 inches; and in the engine room are deep web frames 24 inches deep, while in the boiler room the webs alternate with the channel framing. The longitudinal keel bars are 5 by 5 by 15-20-inch angles.

The shell plating is run in in-and-out strakes, 19 strakes in all, the thickness being 17-20 inch amidships reduced to 13-20 inch at the ends, except for the sheer strake, which is 20-20 inch amidships and 13-20 inch at ends. There are really two sheer strakes, one at the upper deck and one at the second strake below, or at the main deck, and each of these strakes has a doubler for three-fifths length amidships.

The deck beams are 12 by 3 11-16 by 3 11-16 by 9-16-inch channels for all decks, except the main and upper, which are 10 by 3 11.5-20 by 3 11.5-20 by 11.5-20-inch channels.

In lieu of the ordinary pillars and stanchions, there is fitted a system of built-up girders and stanchions. The girders run almost continuously fore and aft at the outboard side of the hatches port and starboard. The girder is made up of 12 by 13-inch channels, with top and bottom plate, and is fitted below each deck. The stanchions are widely spaced and are also built up of 12-inch channels attached to the girder and deck by brackets and clips.

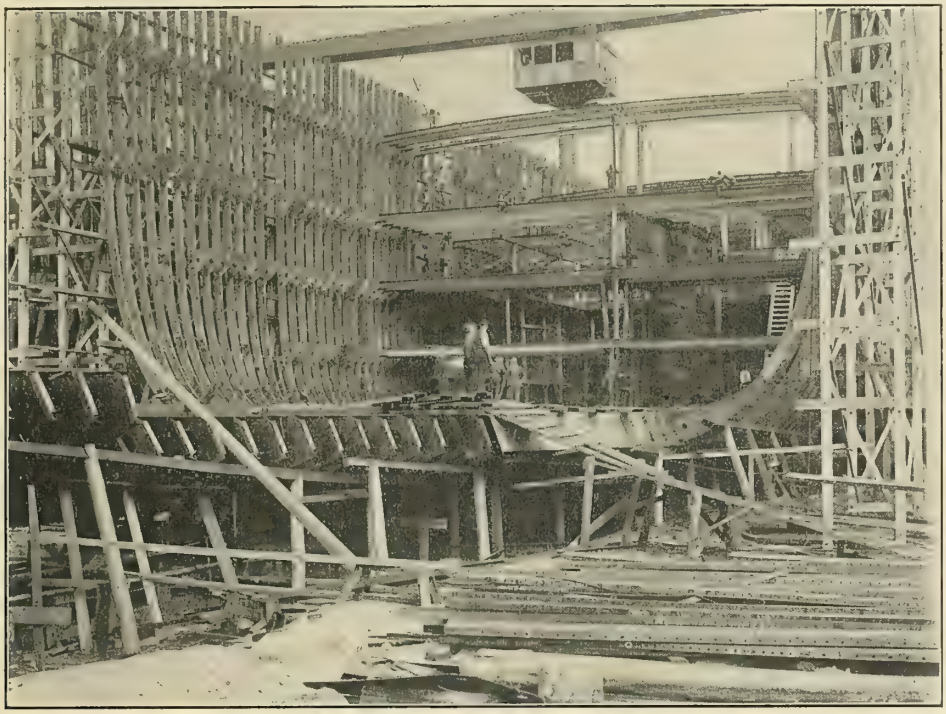
Both the stem and stern posts are steel castings, the former being in two pieces extending from forefoot to the upper deck, and the latter is in four sections and has bolted to it the propeller strut steel castings. The rudder is of cast steel in four pieces, bolted and keyed together, the bottom casting having an overhang forward, tending to balance the rudder; the stock is also of cast steel, 14 1-2 inches diameter, with a palm on its lower end, bolted and keyed to the rudder. There are six steel pintles, 6 3-4 inches diameter, with brass bushings, which may be renewed without removing the rudder. The complete weight of the rudder is carried by a roller bearing on the upper deck in the steering-gear house.



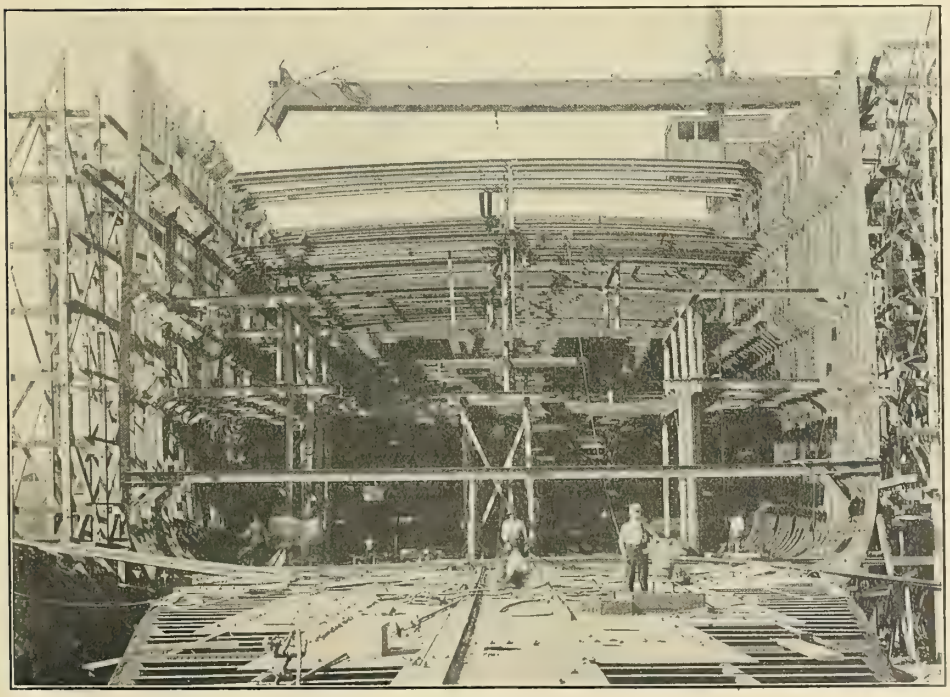
MIDSHIP SECTION OF THE STEAMSHIPS MINNESOTA AND DAKOTA.

The length of the main house is 172 feet on upper and promenade decks, 148 feet on the boat deck, and the chart room and wheel house on the bridge deck is 40 feet long. As will be seen by the midship section, these decks extend to the sides of the ship. The windows of all state rooms in this house are of rectangular shape and have sliding blinds and stained-glass screens and ventilating tops of the Adams and Westlake type. The other

deck erections are a crew's house forward, the third-cabin house, which also contains the refrigerating machinery and is between the crew's house and the main house, and the steering-gear house aft. These will be referred to later.



ERECTING THE FRAMES ON THE DAKOTA, LOOKING AFT.



VIEW ON THE MINNESOTA, SHOWING TANK TOP AND FRAMING.

MACHINERY.

The propelling machinery of the two ships has been built at the works of the Midvale Steel Company, and is of more than usual interest, as the intention of the design has been to give maximum efficiency and endurance with

minimum weight and cost. The main engines of each ship consist of two sets of three-cylinder vertical, inverted, direct-acting, triple-expansion engines with cylinders 29, 51, and 89 inches in diameter by 57 inches stroke, designed for 78 revolutions per minute and to develop about 4,800 horse power each with a steam pressure at the engine of 230 pounds; this is expected to drive the ship at 14 knots speed. The arrangement of the cylinders and valves is as follows, starting at the forward end: High-pressure cylinder, high-pressure piston valve, low-pressure cylinder, low-pressure double-ported slide valve, intermediate-pressure cylinder, and the intermediate-pressure piston valve at the after end of the engine. The sequence of cranks is as usual, namely, high-pressure, intermediate, and low-pressure. The engines are placed in separate water-tight compartments, driving twin screws turning outboard, the working platform of engines also being outboard.

The high-pressure piston has one piston valve, 17 inches in diameter; the intermediate cylinder, one piston valve, 32 inches diameter; and the low-pressure, one double-ported slide valve, 95 inches wide by 59 inches long, all valves having a common stroke of 10 inches. The intermediate and low-pressure valves are fitted with Joy's assistant cylinders, 6 3-4 and 8 3-4 inches diameter, respectively, while the high-pressure valve is partially balanced by having its upper portion enlarged in diameter. The piston valves take steam on the inside.

The cylinders and chests are in four separate castings bolted together; the high-pressure cylinder and chest, the intermediate cylinder and chest, the low-pressure cylinder and the low-pressure valve chest, each being separate castings. Distance pieces are placed between high and low-pressure cylinders and between intermediate cylinder and low-pressure valve chest, allowance being made for expansion. The high-pressure cylinder has an 11-inch diameter opening for steel steam pipe on front of chest, and exhausts into a cast-iron T-pipe 15 1-2 inches diameter, bolted to high-pressure chest at back, thence through a 15 1-2-inch copper pipe with a slip joint at intermediate chest. The intermediate cylinder exhausts through two rectangular passages, each 18 x 12 1-2 inches, made a part of cylinder casting, while the low-pressure cylinder exhausts through a 32-inch diameter copper pipe with a slip joint at condenser.

The cylinders are jacketed. A 2-inch copper pipe connected to throttle-valve casing supplies steam for jackets, the circulation of steam through jackets being continuous from one cylinder to the other, draining at low-pressure jacket, and the pressure reduced at intermediate and low-pressure cylinders. Copper pipes with brass castings and Leslie regulating valves connect the cylinders. The lagging of cylinders and chests is of steel galvanized, with vertical joints; bonnets have rolled diamond plates on top. The filling-in with non-conducting material is most thorough—bonnets, sides, and bottom, with all intermediate space and pipes, being thoroughly covered.

The pistons are of cast steel, coned, except the high-pressure, which is of cast iron, flat, and of hollow section. The framing is of three cast-iron inverted Y housings at back of engine, with six heavy wrought-steel columns at front, the housings carrying the guides, reversing engine, and brackets, and the columns carrying the handling, governing, and indicator gear. The framing is of such proportions as to be thoroughly stiff and rigid, obviating the use of any bracing beyond tying the engines together with athwartship ties at top of housings. The bed plate is of cast iron, box section, very deep, made in three sections; the bottom is made to suit the tank top of ship, being firmly bolted to same. The main-bearing caps are of cast steel lined with white metal, the bottom box of cast steel with a brass bush lined with white metal, and water circulation is provided through top and bottom boxes. There are two bearings to a crank.

The main valves are operated by Stephenson link motion, double-bar links, with eccentric rods 9 feet 9 inches centers. The reversing gear consists of a direct-acting steam cylinder, with oil cylinder on top, size 14 by 7 by 26 3-4 inches stroke, controlled by the usual floating lever with rod led to front of engine with lever and quadrant. The reversing shaft is 8 inches diameter, 23 feet 1 inch long, with cast-steel arms; reversing arms are arranged for linking in and out. There is also provided an oil pump for hand reversing, 2 1-8 by 4 inches stroke, of the single-acting plunger type.

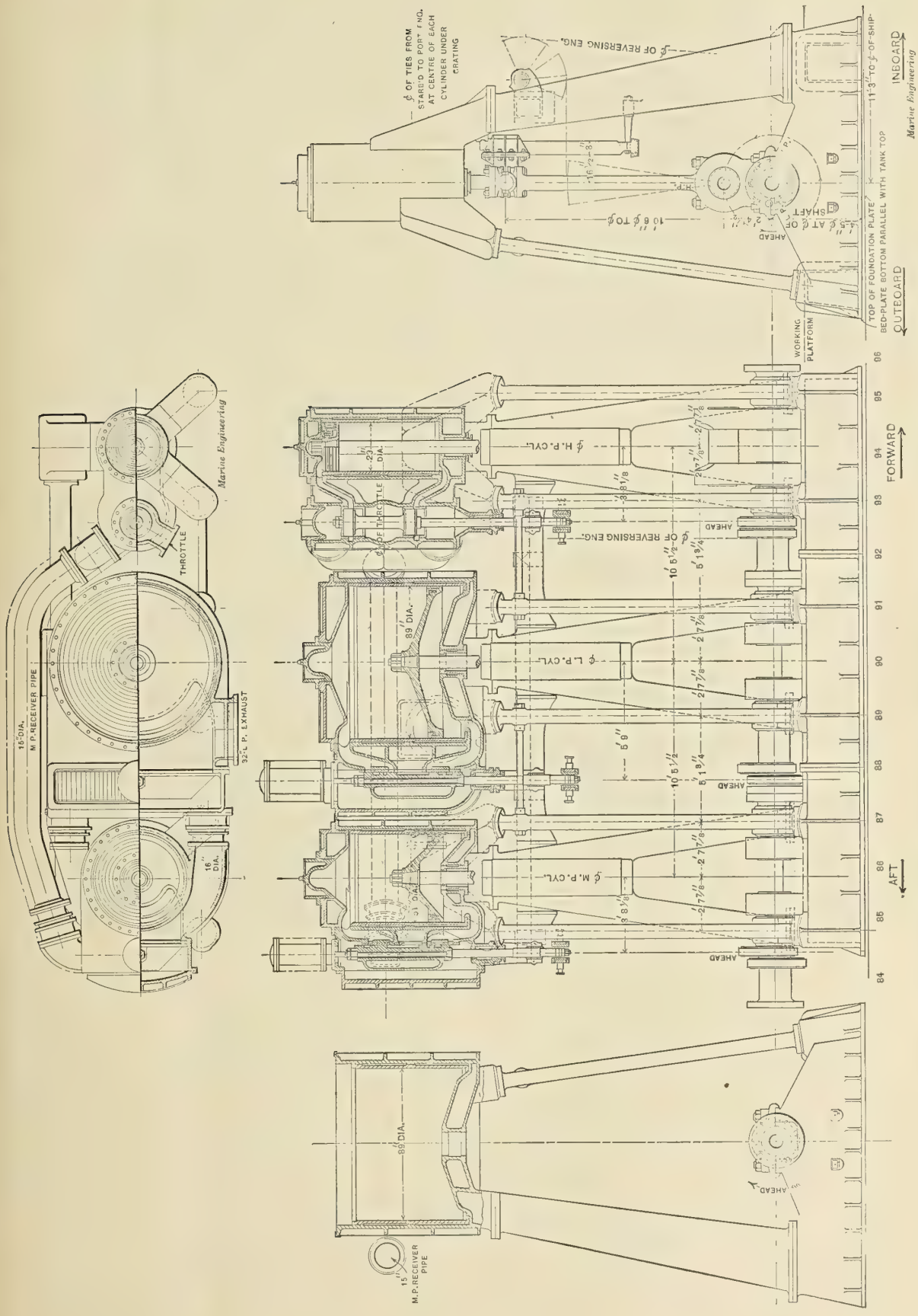
The connecting rod is 10 feet 6 inches centers, 10 inches diameter at crank end, 8 inches at fork end. Crank end has brass bushes lined with white metal, 18 inches diameter, 20 inches long, while crosshead end has brass boxes each 10 inches diameter by 11 inches long. The crosshead block is 13 by 13 inches, journals 10 inches diameter by 11 inches long. The slipper is of cast steel, bolted to crosshead, faced with white metal; size, 24 inches wide, 30 inches long, and with astern surface two-thirds of ahead. The piston rods are 8 inches diameter in stuffing box, tapered in pistons and crossheads, 6 inches over threads at ends, total length 10 feet 9 1-8 inches. Katzenstein's metallic packing is used for both piston and valve-stem stuffing boxes.

The crank shaft is of the built-up type, in three interchangeable sections. Each section is 10 feet 5 1-2 inches long from coupling to coupling, pins and shafts 18 inches diameter with 8-inch diameter holes bored axially in same; pins and shafts are finished all over. The webs are machine finish only, figure 8 shape, 12 1-2 inches thick, 37 1-2 inches diameter at ends. Couplings 31 1-2 inches diameter, 4 1-2 inches thick, with 9 taper bolts 2 5-8 inches diameter at thread, tapering from 3 to 3 3-4 inches on 25-inch diameter pitch circle.

These crank shafts are so accurately finished that when placed on the inspection V blocks they were but 2-1000 of an inch out in alignment and diameters of the journals and pins. This accuracy in finish is characteristic of this company's work, as all measurements are made and checked with micrometers, the final inspection being made on an inspection bed specially provided for this class of work, and is within 1-1000 of an inch of perfect accuracy.

The thrust shaft is 18 1-8 inches diameter, 14 feet 4 inches long, with 9 collars 2 1-2 inches thick, 27 5-8 inches diameter. The thrust bearings are of cast iron with cast-steel horseshoes lined with white metal, and each shoe has water circulation, and collars of shaft also run in oil bath. Steady bearings are provided at each end.

The intermediate shafts are six in number, each 17 inches diameter, 22 feet 6 inches long, and two Verity



ONE OF THE THREE-CRANK, TRIPLE-EXPANSION ENGINES BUILT BY THE MIDVALE STEEL COMPANY FOR THE STEAMSHIP MINNESOTA.
Intermediate cylinder is fitted with piston valve, the design having been changed from that shown in drawing.

flexible couplings are on each line of shafting, one coupling forward of stern tube and the other forward of shaft-alley forward bulkhead in thrust recess. Two separate lengths of shafting, each 7 feet 6 inches long, take these couplings, the after end of thrust shaft meshing with forward Verity shaft forming one, and the forward end of tail shaft meshing with after Verity shaft forming the other coupling.

The tail shaft is 19 inches diameter, 36 feet 9 1-4 inches over all, with brass sleeves for bearings, and covered with brass liners between the sleeves; the joints between liners being made male and female with a white-metal ring, calked. The total length of one line of shafting from forward coupling of the high-pressure cylinder to end of tail shaft is 232 feet 5 3-4 inches.

Steady bearings are of cast iron, lined on bottom with white metal, fourteen bearings on each line of shafting.

Each propeller is a true screw, three bladed, with cast-steel hub and blades of the following dimensions: Diameter 20 feet, pitch 22 feet 6 inches, developed surface each wheel 98.7 square feet, projected surface 81.6 square feet. The blades are secured to hubs by 3 1-4-inch diameter steel studs, 9 for each blade, holes ovaled, giving a range of pitch adjustment from 21 feet 6 inches to 23 feet 6 inches.

A complete oil and water system is provided, extending to all parts of the main engines. The oiling is by wick feed, from brass oil boxes on cylinders for main moving parts, separate boxes being fitted for each main bearing and eccentric, while eccentric-rod pins and links, reversing bearings, etc., have separate boxes of locomotive type. Water circulation is provided for guides, main bearings, and thrust-bearing shoes, sprays and pipes for all other parts, with a very complete system of cocks and swing joints. All piping is of brass.

The handling gear is located on column side of engine, operated from the working platform at crank pits. On the after column of the high-pressure cylinder is an 18-inch diameter hand wheel operating the stop valve, which is of the piston-balanced type, 11 inches diameter, bolted to the front high-pressure chest. The cock admitting steam to the balance piston is worked by lever at this same column. At the forward column of low-pressure cylinder are the levers for throttle valve and reversing engine. The throttle valve is of the butterfly type, 11 inches diameter, bolted to under side of stop valve. This valve is automatically controlled by an Aspinall governor which is carried on a special lever worked from the low-pressure crosshead. A disconnecting arrangement is provided for disconnecting the governor gear when in port, enabling throttle to be worked directly by hand lever.

On the after column of the low-pressure cylinder are the levers for operating the drain cocks, one lever for each cylinder. The cylinder cocks are 2 inches diameter, steam chest cocks 1 1-4 inches diameter, connected by separate levers to a 1 1-4-inch cold-rolled shaft led fore and aft at front of upper column feet. The operating lever for each cylinder opens or closes the cylinder and chest drains of that cylinder simultaneously. All drains lead to condenser.

The condenser is of sheet steel 7-16 inch thick, 6 feet 8 inches inside diameter, made from three sheets circumferentially, stiffened by three 3 1-2 by 3 1-2 by 1-2-inch angles with two bounding angles 3 1-2 by 3 1-2 by 13-16 inches.

The heads are of cast iron, the tube sheets 1 1-8 inches thick, of rolled brass; supporting plate, 3-8 inch thick, of rolled brass. There are 2,456 7-8-inch tubes, 12 feet long between tube sheets, giving 6,750 square feet of cooling surface. The circulating water is passed twice through the condenser, being supplied by a 20-inch centrifugal pump delivering 8,000 gallons per minute, and driven by a 10 by 20 by 10-inch vertical compound engine of 80 horse power. One 6 by 6 by 6-inch vertical engine, to run at 300 revolutions per minute with 100 pounds steam pressure, is provided for turning both main engines, being connected to same by an athwartship length of shaft, in two pieces, with clutches provided on each end of turning engine crank shaft, fitting into corresponding clutches on connecting shafts. These clutches are so arranged and operated by a hand lever that only one main engine at one time can be turned over. This athwartship shaft drives a worm and wheel (ratio 30:1) at each main engine, this latter wheel being keyed on a vertical shaft with a worm on upper end, which worm meshes into the turning wheel on main engine shaft (ratio of last worm and wheel 60:1).

Provision is made for hand turning; the turning engine is operated by a change valve. Attached to forward coupling of main engine crank shaft is a cast-steel disk with a pin driving two single-acting, plunger bilge pumps, each 6 inches diameter, 10 inches stroke.

The high grade of steel work turned out by this company is of special mention. All the steel forgings and castings are thoroughly annealed, tested, and every requirement fully met.

Of the above machinery all shafting is of high-grade open-hearth steel, oil tempered and annealed, 80,500 pounds tensile strength, and 46,000 pounds elastic limit. The crank webs, connecting rods, and other main forgings are of open-hearth steel, 70,000 pounds tensile strength, 40,000 pounds elastic limit.

The weights of machinery for each engine are about as follows:

Cylinders, housings, and bed plate	350,650	pounds
Thrust and steady bearings	20,000	"
Stern tube and B. H. stuffing boxes	17,800	"
Columns	23,500	"
Crank shaft and one complete line of shafting	169,000	"
Connecting rod and main reciprocating parts	38,500	"
Valves, links, and gear	24,000	"
Reversing engine, shaft, and gear	8,600	"
Indicator, governor gear, grating, hand rails	4,250	"
Copper piping	2,050	"
Brass piping, casting, and valves	2,250	"
Lagging and covering	10,300	"
Bilge pumps	875	"
Propeller	42,000	"
Turning engine and gear	4,840	"
Spares	38,000	"
Condenser	49,850	"
Circulating pump	12,565	"
Total for one engine	819,030	"

BOILERS.

Each vessel will have 16 Niclausse water-tube boilers, built by the Stirling Company, the arrangement being shown in the drawing on page 231. The sizes and surfaces are as follows:

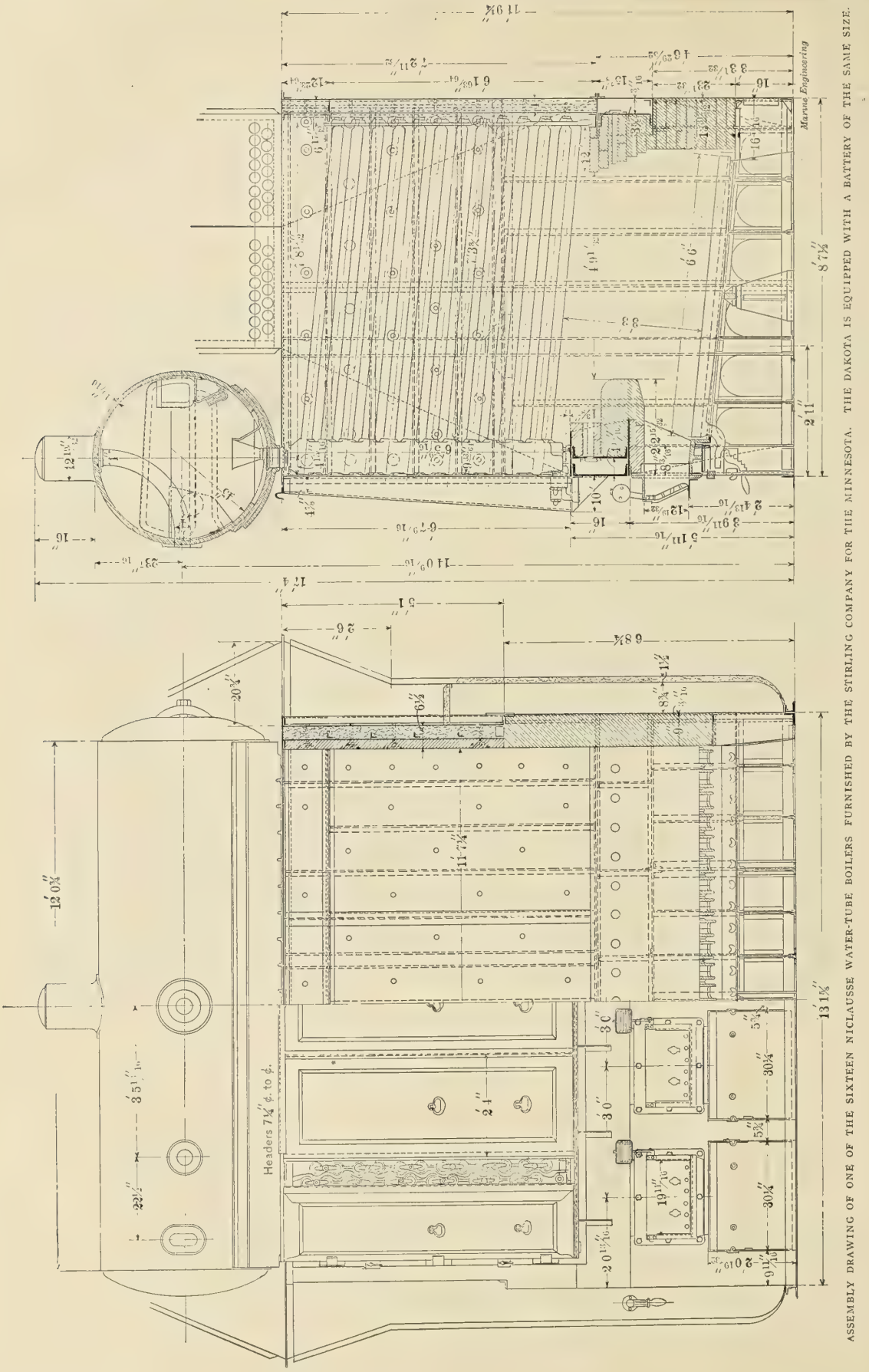
Four	19-element	.....	11,244	H. S.;	302	G. S.
Four	19	"	10,656	"	286	"
Two	17	"	4,032	"	135	"
Six	15	"	13,332	"	357	"
	Total	.....	39,264	"	1,080	"

this end fits into a tapered hole in the rear face of the header, while the other end of the tube is sealed by a steel cap. A sleeve with a flexible joint is fitted into the front end of the tube through both headers, the tapered surface fitting the front face of the header. This sleeve also contains a smaller sleeve, which holds the inner or circulating tube, of less diameter, which is inserted almost the entire length of the generating tube. The sleeves are held in place by a dog and can be very easily removed and replaced. The water circulation in these boilers is positive. The feed water enters a tray in the

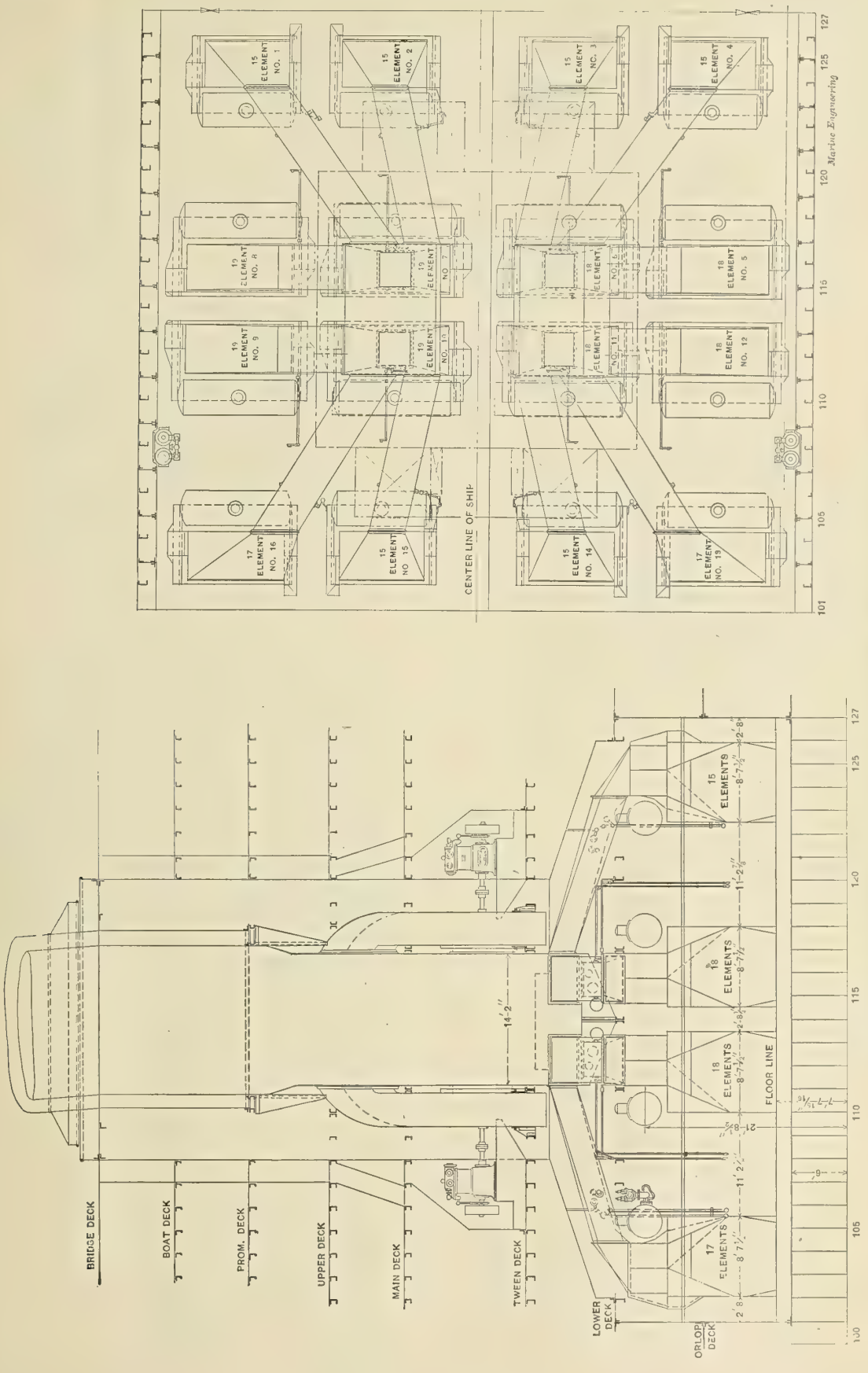
NICLAUSSE BOILERS FOR THE MINNESOTA AND DAKOTA, ERECTED IN THE TESTING SHOP OF THE STIRLING COMPANY.

The boiler room, as the engine room, is divided by a center-line bulkhead, eight boilers in each room, arranged fore and aft, with two thwartship fire rooms.

The detailed drawing of the boiler is given on page 230, and a view of the boilers mounted on the testing floor of the Stirling Company is shown on this page. The boilers are to carry a working pressure of 250 pounds, and when set up complete were tested to 500 pounds hydraulic pressure. The boiler consists of a steam drum and a series of headers, into which tubes are fitted. The field tubes, set at an angle of 6 degrees to the horizontal, are arranged as in the sectional drawing, and each header is divided into two compartments. The outer, or generating tubes, are upset at one end to a diameter slightly in access of that of the tube itself, and drum, is heated to the temperature of the steam, and impurities are precipitated. Overflowing the drum, it descends the front compartments of the headers and back through the inner tubes to the extreme end, where it turns and passes to the front through the only space between the tubes. The mixed water and steam then pass upward through the angle compartments of the headers and discharge into the drum. The drums are 45 inches in diameter, 15-16 inch thick, while the generating tubes are of seamless cold-drawn steel, 3 1-4 inches outside diameter and No. 6 B. W. G.; the circulating tubes are 1 19-32 inches outside diameter by 21 B. W. G. All the material used in the boilers, and their final acceptance under steam, are subject to the approval of Lloyds.



ASSEMBLY DRAWING OF ONE OF THE SIXTEEN NICLAUSSE WATER-TUBE BOILERS FURNISHED BY THE STIRLING COMPANY FOR THE MINNESOTA. THE DAKOTA IS EQUIPPED WITH A BATTERY OF THE SAME SIZE.



ELEVATION AND PLAN OF BOILERS AND UPTAKES ON THE MINNESOTA, BUILT BY THE EASTERN SHIPBUILDING COMPANY.

A donkey boiler is placed on the deck and is of the vertical tubular type, 5 feet in diameter, 10 feet 6 inches high, and has a grate surface of 16 square feet and a heating surface of 692 square feet, furnishing steam at 150 pounds pressure. The ship has but one stack, elliptical in form, 16 feet by 13 feet, and 124 feet 10 inches above the grates.

PUMPING OUTFIT.

All the steam pumps used, including the auxiliary and main condenser air pumps, are of the Blake type. There are two circulating pumps of the usual centrifugal type, each driven by an independent compound engine with cylinders 10 and 20 inches diameter by 10 inches stroke, built by the Morris Machine Works. A list of the pumps, including those of both engine rooms, is as follows:

Two vertical simplex cross-connected air pumps, each pump with two 10-inch steam cylinders, two 20-inch pump cylinders, common stroke of 16 inches.

Two main feed pumps, 18 and 10 by 18 inches, vertical simplex type. Two auxiliary feed pumps, vertical compound duplex, the steam cylinders being 12 and 18 1-2 inches diameter and the water cylinders 8 inches diameter, all with a common stroke of 12 inches. The water is raised from the hot well by two pumps, 8 inches, 12 by 12 inches, of the vertical simplex type, and lifted into the feed-water jet heaters, from whence it is taken by the main feed pumps to the boiler.

There are two horizontal compound duplex ballast pumps, 8 inches, 12 and 14 inches, by 18 inches stroke. The fire pump is of the same type, the dimensions being 14 inches, 20 and 14 inches, by 18 inches.

There is one general service donkey pump, with compound duplex pistons, 14 inches, 20 and 10 inches, by 12 inches stroke.

The salt-water sanitary pump is 8 and 12 by 10 1-4 inches by 10 inches, compound duplex, and the fresh-water sanitary pump is a vertical compound duplex with cylinders 5 1-4, 7 1-2, and 7 1-2 inches by 6 inches. There is an auxiliary sanitary horizontal duplex pump, 10 and 10 1-4 by 10 inches. The fresh-water pump is of the vertical simplex type, the dimensions being 4 1-2, 6 by 6 inches.

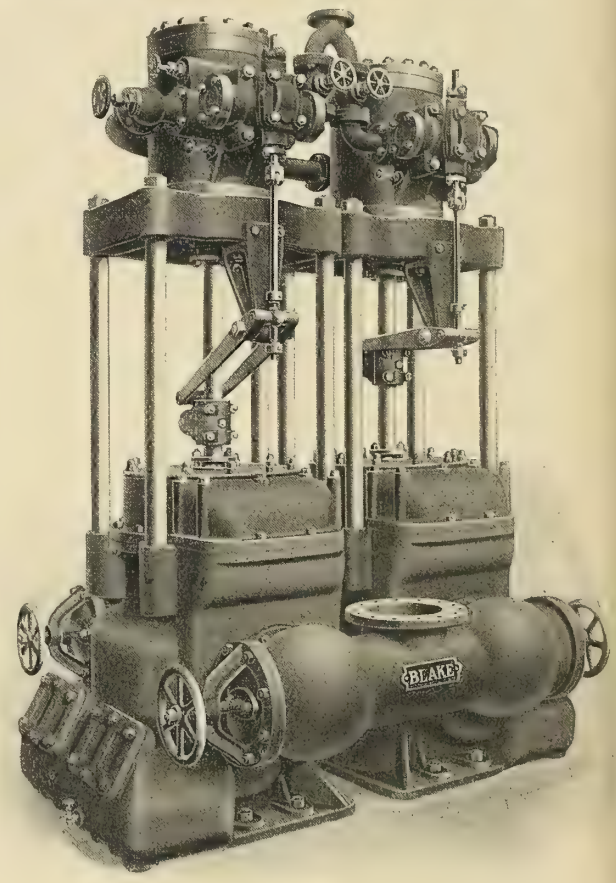
There is one oil pump, 3 and 2 inches by 3 inches, of a special horizontal duplex type, and the test pump of the same type used for donkey boiler feed is 6 and 2 3-4 inches by 6 inches stroke.

The other pumps installed are as follows: One evaporator lift pump, 3 by 2 by 3 inches, special duplex; two crank-pit oil pumps, 2 by 1 1-4 by 2 3-4 inches, special duplex; two refrigerator brine pumps, 4 1-2 and 6 1-2 by 6 by 7 inches, horizontal compound simplex; one air-compressing pump for potable water tank, 6 by 6 by 7 inches, vertical simplex; and two combined fresh- and salt-water distillery pumps, 4 1-2 by 3 3-4 by 3 3-4 by 6 inches, horizontal simplex.

There are two auxiliary air and circulating pumps, 12 inches steam by 14 inches air by 14 inches water by 12 inches stroke, of the horizontal simplex type, having a Wheeler Admiralty condenser with about 800 square feet of tube surface mounted on top. There is also a supplementary auxiliary air and circulating pump, 6, 8, and 8 inches by 7 inches stroke, of the same type, mounted on Wheeler condenser with 250 square feet of tube surface.

There are four single-acting horizontal bilge pumps, 6 by 10 inches, two being connected to each of the main engines on the forward end of the engine bed plate.

The feed pumps, located in each of the boiler rooms, have a capacity of 17,000 gallons of water per hour, and each is capable of supplying the water for 7,000 horse power. The ballast pump is connected to act as an auxiliary circulating pump, and the fire pump, placed under the condenser in the port engine room, has practically a universal suction and discharge, as it is connected with all the tanks and bilges and is fitted to act as an auxiliary ballast pump. The capacities of some of the pumps are as follows: Two ballast pumps, 300 tons each per hour; one fire pump, 300 tons per hour; donkey pump, 280 tons per hour; salt-water sanitary, 150 tons per hour; fresh-water sanitary, 50 tons per hour; auxiliary sanitary, 150 tons.



VERTICAL SIMPLEX AIR PUMP FOR THE MINNESOTA.

The main independent air pumps, one of which is here illustrated, are built without any suction valves whatever. The elongated air pistons, passing central ports located on the suction side of the cylinders, perform the same service as suction valves. The air pistons, having no valves (such as the buckets of a regular single-acting air pump possess), can approach the cylinder heads within one-eighth of an inch, consequently the clearance space is reduced to a minimum—an important feature in securing high vacuum-forming efficiency. These air pistons are cast hollow and filled with water-excluding material, having but little weight and requiring no pack-

ing. The discharge valves at top and bottom are easily accessible.

As shown by the engraving, both the steam cylinders and air cylinders are provided with valves, cocks, and connections, so that either side can be run separately, should occasion require, thus practically providing a spare pump. The time required to change from running both sides together to running one side separately is less than one minute. Another advantage possessed by these pumps is their exceedingly light weight—about half that required for ordinary connected air pumps of the single-acting type.

One of the novel features in the pump equipment is providing a special salt-water pump to supply the water for a portable swimming pool that can be readily set up on the main deck during favorable weather, thus affording passengers the luxury of a daily salt-water plunge bath when the weather is favorable. This swimming pool is constructed of water-proof canvas arranged in a suitable manner, and will have a capacity of many tons of water.

In each engine room is a feed-water filter, made by the Blackburn Smith Company, capable of filtering all the feed water when the boilers are working under forced draft. The filters on the fresh-water sanitary system are furnished by the James Reilly Repair and Supply Company.

Besides the two main condensers there are four auxiliary condensers, furnished by the Wheeler Condenser and Engineering Company.

AUXILIARIES.

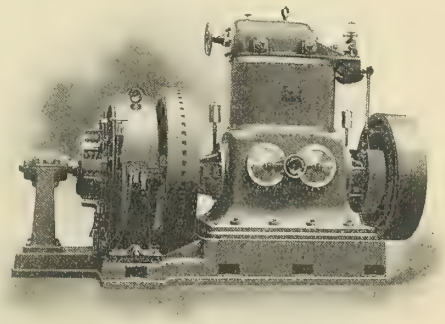
The evaporating plant is very large and complete, and consists of four evaporators, two distillers or condensers, two feed-water heaters, and one filter. It is arranged to be operated in single, double, triple, or quadruple effect. The evaporators, made by Williamson Brothers, are located in the forward ends of the engine rooms at the level of the engine-room floor. Connection is made so that steam from either the intermediate-pressure receiver or the auxiliary steam line, in which the steam is at 150 pounds pressure, may be connected to the evaporator. The exhaust from the evaporators is led to the low-pressure receivers.

A system of mechanical draft is installed in the boiler rooms, there being four 9-foot fans, each connected to a Westinghouse compound engine with 9 and 15 inches by 19 inches cylinders, elsewhere described. Induced draft is used, the fresh air being drawn through heaters in the uptake, through the boilers, round the air heaters, and is exhausted by the fans into the base of the stack.

Both steam and electric steering gear is installed, the steam being used for emergency and the electric for ordinary service. The gear and engine were made by Williamson Brothers, and are the same type as used in the White Star and Atlantic Transport Line ships. Both gears are directly attached to the quadrant in the steering house aft. The arrangements for steering are very complete. The chart and wheel house is placed at the forward end of the bridge deck, the wheel house containing wheel and compass. Immediately forward of this is a steel screen, extending under the full front of the deck. Stairs lead from here to the navigating bridge above, which also has a wind screen entirely around it. Behind this screen are located the engine telegraph, steering telegraphs, docking telegraphs, whistle operators, etc., also a complete officers' telephone communication.

ELECTRICAL EQUIPMENT.

The electric-generating outfit, which is very complete indeed, is located in the forward end of the engine room on a platform at the level of the orlop deck. There are six direct-connected Westinghouse generators, each of 75 K. W., driven by a Westinghouse compound vertical engine, 11 and 19 inches by 11 inches stroke. Each generator is a 6-pole machine, furnishing direct current at 110 volts when making 300 revolutions a minute. The Westinghouse engine, as generally known, is single-acting, taking steam on the downstroke only. The cylinders are cast together, and the horizontal steam chest is lined with a hard-iron bushing, which may be ringed. One piston valve controls the admission and exhaust of steam to both these cylinders and is packed with four springs. The pistons are of a trunk pattern and each



GENERATING SET FOR THE MINNESOTA.

is fitted with a pin, corresponding to a crosshead pin in other engines, with which the upper end of the connecting rod engages. The pins are case-hardened and accurately finished to gage. The pistons are packed with cast-iron spring rings. The main bearings consist of two cast-iron shells lined with babbitt and the lower half adjustable. There is also a center bearing between the two cranks, which is also adjustable. The connecting rod consists of a continuous forged strap, which is fitted with brasses at top and bottom, and the lower box is held in place by heavy bolts, and the inner halves of the upper and lower boxes are held apart by a forged steel strut or distance piece. The crank shafts are forged in one piece from open-hearth steel. The cranks revolve in a closed case, and, at the bottom, dash through oil or water, and thus carry lubrication to all moving parts. A Rites governor acts directly on the main valve.

The electric-light installation consists of about 1,300 lights, distributed throughout the ship, and a powerful 24-inch searchlight, of the General Electric make, placed on the forward lookout bridge. This light can be operated from the navigating bridge by an electric or hand gear. All electric fixtures were furnished by Page Brothers and Company. The powering and lighting is on the three-wire system, and several switchboards are conveniently placed throughout the ship.

Motor drive is used for the refrigerating engines, cargo winches, ventilating fans, and warping capstans, which will be described under the succeeding headings.

REFRIGERATING PLANT.

The refrigerating plant referred to above is very ample, and is in duplicate sets consisting of two 30-ton marine ammonia compressors furnished by the American Linde Refrigerating Company. Each compressor is driven by a 75-horse-power direct-connected General Electric motor, mounted on a wrought-iron bed plate which contains the ammonia condenser coils. The coils are galvanized and so built that all points are on the outside of the condenser, in full view of the attending engineer. The plant also consists of two brine refrigerators, two air coolers, one ice-making tank, and one water cooler for cooling the filtered water which is supplied to the drinking fountains throughout the first-class accommodations. The entire plant is located in a deck house forward, as shown in the inset drawing.

The brine refrigerators are circular in form and contain the refrigerator coils. The special feature of the plant is the Linde patent air cooler, by which the temperature of the refrigerating holds is regulated. Each cooler contains a number of pipes, through which is passed the cooled brine. The brine is then sprayed over these pipes, and the air, which is drawn from the holds by electric-driven blowers, is forced along the outside of the cold pipes and through the spray. Thus the air is not only cooled but thoroughly washed by the brine, which also absorbs the impurities. The air is then delivered back into the hold dry and purified.

Besides the cooling of the holds which are for carrying cargo, the plant will also cool the different insulated chambers used for storing ship's provisions. As the machinery is supplied in duplicate, every protection has been taken to avoid a complete breakdown.

VENTILATION.

The system of ventilation in these vessels is very complete and efficient and comprises a fresh-air supply and an exhaust system. Fresh air is passed over heating or cooling coils for winter or summer service, respectively, and delivered into the passages and hallways, while the exhaust system draws the air from the state rooms and other parts of the vessel. These heaters and coils are furnished by Joseph McCreery. Besides this mechanical ventilation, there is fitted in all the cabin spaces a complete system of natural ventilation. This system is also used for ventilating the cargo and coal spaces. The entire problem of ventilation has been worked out in great detail, there being no less than seventy-two motor-driven blowing and exhausting fans, furnished by the New York Blower Company. These fans are direct-connected to Westinghouse motors.

ANCHORS, WINDLASSES, ETC.

The anchor-handling and warping appliances consist of a specially heavy Hyde windlass operated by a vertical compound engine placed on the forecastle deck. The windlass has two wildcats for handling 3 3-16-inch stud link Lebanon chains and two niggerheads. These wildcats are driven by two separate vertical shafts which extend through the upper deck and may be rotated together or independently. Two extra heavy chain stoppers of the navy type are fitted, also a capstan on each side of the windlass, operated by the windlass engine. Two similar capstans are fitted aft for warping the ship and are electrically driven by General Electric motors. There are three stockless anchors, supplied by the Admiral Anchor Company, their weights being respectively 16,800 pounds, 14,000 pounds, and 12,230 pounds. The chains above referred to are the heaviest ever made, sold by the Newhall Chain Forge and Iron Company, and the weight of the anchors, chains, etc., amounts to the great figure of 130 tons.

The life-saving appliances include belts, buoys, rafts, and boats. There are 15 metallic lifeboats, one metallic launch with alco-vapor motor, one wooden rowboat, and five metallic rafts.

For the purpose of extinguishing fires in the hold, steam pipes are laid into each cargo space; the controlling valves for same, being located on the upper deck, are at all times accessible. For the passenger spaces water service is provided for this purpose, and large escape ports are fitted below deck for carrying off this water.

COAL BUNKERS.

The cargo and coal capacity of these vessels is very large, and well shown in the accompanying plans. The coal bunkers are arranged to be self-trimming by means of sloping bulkheads, the after boiler-room bulkheads sloping about ten frame spaces, and the forward boiler-room bulkhead sloping forward about thirteen frame spaces, extending to the upper deck. The space between the main and upper decks is arranged to be used for either cargo or coal, and the length of this space on the main deck is about 120 feet. Coal chutes lead from these spaces directly to the fire rooms. The capacity of the trimming bunkers is over 4,000 tons, and in the reserve bunker space contiguous to the boiler rooms 2,000 tons of coal may be carried in addition.

CARGO SPACE.

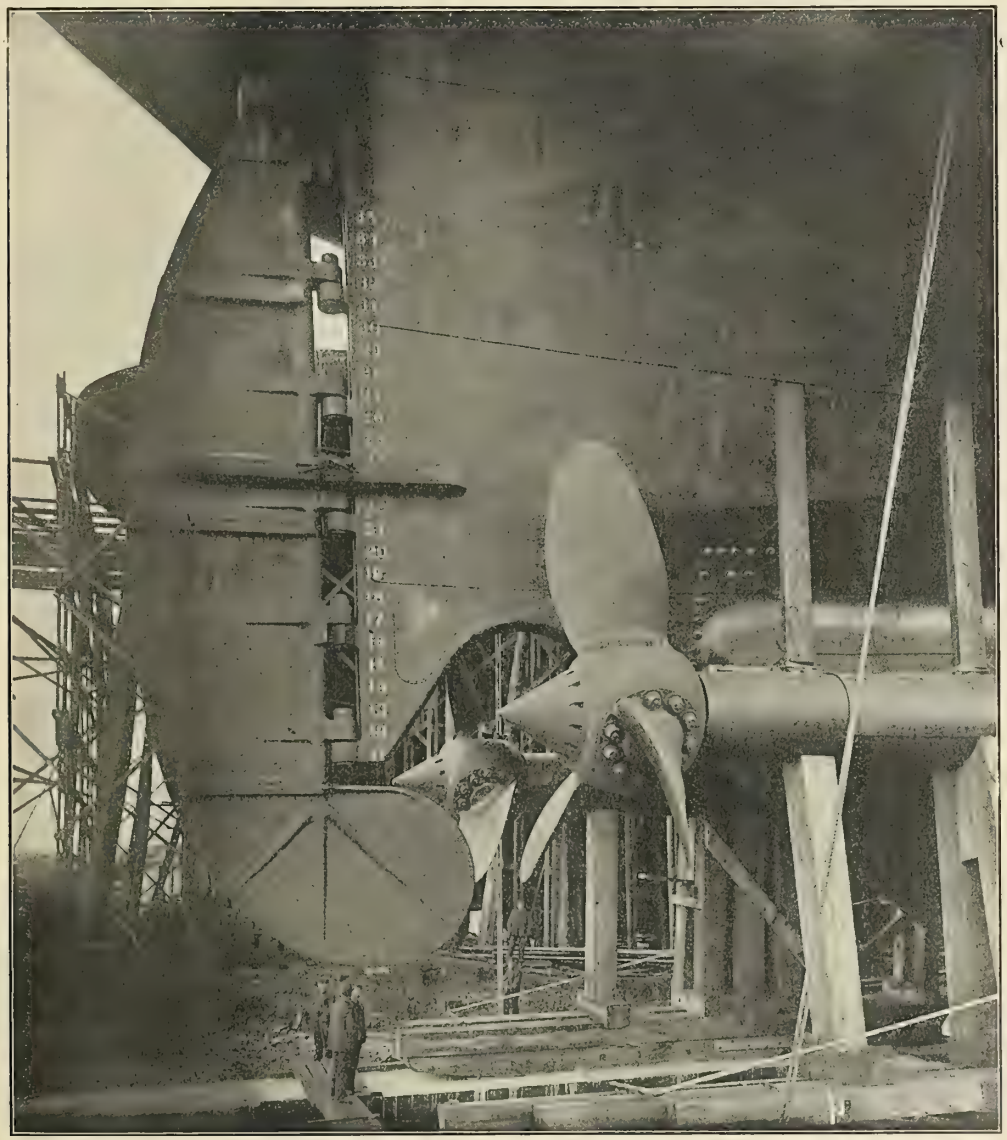
The arrangement of the decks and hatches may be followed in the drawings on the inset, and in the drawing of the upper deck is given the layout of the cargo-handling appliances, showing the position of masts, booms, winches, and hatches. It will be seen that forward of the main house there are four hatches for cargo. The forward hold, just aft of the crew's house, is entirely devoted to cargo on each of the four decks. The four forward booms on the foremast serve this hold, the hoists being driven by four winches. The arrangement is such that one boom remains over the hatch, while the other swings over the side and brings the cargo over the hatch, where it is lowered by the stationary boom. The booms rest on a platform on the mast about 8 feet 6 inches above the deck. The hold aft of this is again entirely for cargo, the four after booms on the foremast and four winches operating it.

The next space is the refrigeration space, containing a silk room and an air-cooling room. The hatch above the upper deck is trunked through the second-cabin house. At the after corners of the house are two derrick posts, each with two booms, which handle the cargo in this space. Aft of this is a very large hold, designed for large and heavy cargo. The orlop deck is discontinued in way of this hold, giving a clear height above the tank top of 18 feet. The four booms on the mainmast and four winches operate this hatch. Besides this, there is a large 50-ton boom, which steps

just forward of the mainmast on the upper deck, for handling heavy cargo. Two winches are arranged so they can be coupled together to operate this boom.

The next hold is almost entirely devoted to ship's provisions and use as a reserve coal bunker.

Aft of the main house there are four holds, all of which are entirely for general cargo. The one just aft of the house is operated by four booms on the mizzenmast and four winches. It is arranged so that a boom can be stepped on the fore side of the mizzenmast and swung over the engine hatch on the bridge deck. For the hatch aft of this there are two derrick posts, each with two booms and four winches. The other two hatches are operated by eight booms on the jiggermast, four on the fore side and four on the after side. A 30-ton boom steps on the forward side of the mast on the upper deck. All the masts step on the 'tween deck. On the bridge deck there are four small 1-ton booms and posts for handling coal. They are arranged to swing over the side and to the coal trunks. The winches operating these can be used for handling the boats. The booms are lowered into rests when at sea. It will be seen that there are 38 cargo winches, all of which were furnished by the Lidgerwood Manufacturing Company. The winches are driven by General Electric series-wound armored motors, each with a controller of the railroad type. The winches are of the following capacities: Twenty-six 25 horse power of 3,000 pounds capacity each; eight 40 horse power of 5,000 pounds; one of 7,000 pounds; two of 10,000 pounds; and one of 14,000 pounds.



CAST-STEEL RUDDER AND PROPELLERS OF THE STEAMSHIP MINNESOTA.

[Photographed specially for Marine Engineering by Enrique Müller.]

PASSENGER ACCOMMODATIONS.

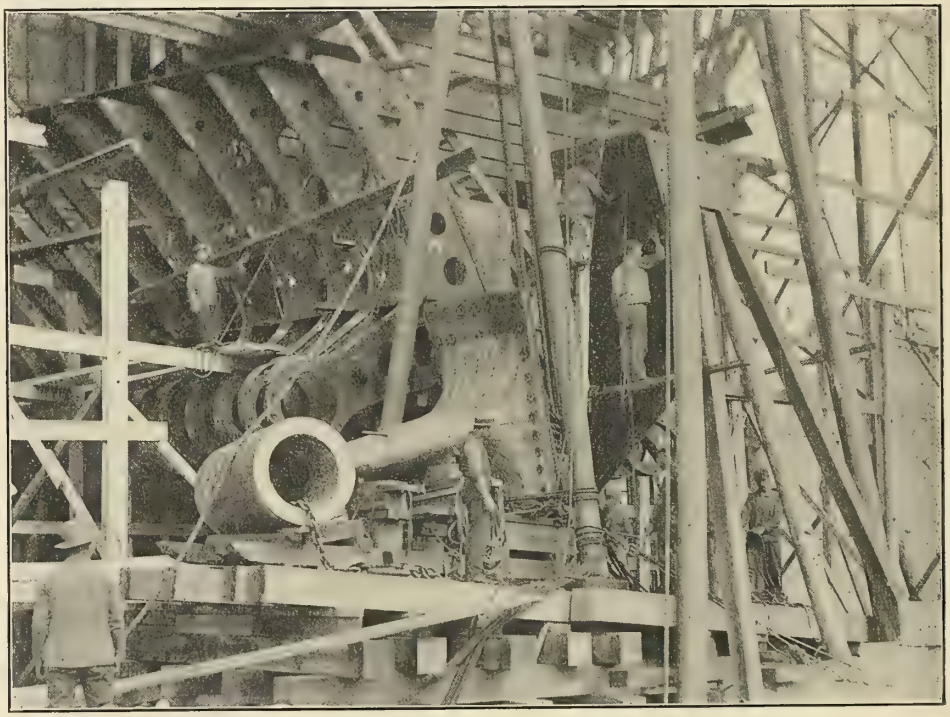
The passenger accommodations are very commodious and are found on the main, upper, promenade, and boat decks. The crew accommodations are on the main deck in the fore peak and the forecastle deck—a short deck in the fore peak between the main and upper decks.

There are accommodations for 172 first-class passengers, 111 second-class, 68 third-class or white steerage, 1,067 steerage, and 1,377 troops, and a crew of 240 men. On the bridge deck forward are the chart room and wheel house and quarters for ship's officers. The pilot house is in the forward end, and leading from this is the chart room and captain's sitting room, while still further aft are the captain's state room and bath. The pilot house is finished in wainscoting of dark-stained cherry, the upper paneling being of quartered oak. The chart room and captain's sitting room are finished in cherry and oak, with dark reddish brown upholstery. The state room has a fixed bedstead and a wardrobe, and the cabin a table, upholstered seat, roll-top desk, chairs, etc.

The first-class passenger state rooms are found on the upper, promenade, and boat decks. In the forward end of the main house on the upper deck is the dining saloon, extending the full width of the house, with a seating capacity of 140. This room has dark, rich mahogany side paneling, rectangular windows with mahogany sliding shutters; also stained-glass windows with ventilators above lights. The ceiling and beam capping are of white staff; the floor is hard wood, carpeted between tables; the furniture is mahogany, and the furnishings of old-gold curtains, draperies, and upholstery.

Just abaft the dining saloon is the main hall, with grand staircase leading to the hall and state rooms above on the promenade deck. Aft of this, along the sides of the house, are state rooms. In the center of the house and forward of the boiler casing are commodious lavatories; forward of this, extending to the staircase, is the pantry.

The library and ladies' sitting room are in the forward end of the main house on the promenade deck, just above the dining saloon, the library being on the port side and the ladies' room on the starboard. The ladies' room is paneled with selected maple, with occasional light gold decorations, while the ceiling is of staff, delicately tinted. The floor is of polished maple and covered with a number of rugs. The upholstery is of dark olive green, with draperies of lighter shades of green, and the windows have sliding maple shutters, also stained-glass shutters of attractive design. The room has a large open fireplace, numerous cozy corners, and a grand piano with a maple case. The library is finished with side paneling of mahogany, and all the furniture is of the same wood, upholstered with a dark, rich shade of leather, tufted; the ceiling is again of white staff and the floor is red and white interlocking rubber tile.



CAST-STEEL PROPELLER STRUT BEING ERECTED IN PLACE ON THE MINNESOTA.

A nursery, or children's play room, is located on the promenade deck between the engine casings, and is finished with dark-stained cherry wainscoting; the upper side paneling is also of cherry, natural finish, with selected panels. The ceiling and beam capping are of white finish and the furniture is dark-stained cherry. The floor is carpeted with a dark, rich, figured carpet. Round air ports in the engine casing are fitted with ground, figured glass, and at the after end are rectangular lights with shutters and ventilators.

The remainder of the house on this deck is devoted to state rooms. A staircase in the hall leads to a large social hall on the boat deck, which is almost entirely given over to state rooms. There are several commodious suites, consisting of bed room with large, double brass bedstead and upholstered chairs and seats; this opens

into a sitting room with upholstered extension sofa, seat, table and chairs, and this in turn leads to a bath room. Simplex electric heaters are fitted in all first-class state rooms and public rooms.

In the after end of this house, just forward of the engine casing, is the smoking room, extending the full width of the house, and in the forward end is an enclosed bar. The side paneling of the smoking room is quartered oak, natural finish, with rosewood wainscoting. The furniture is all of rosewood with reddish-brown tufted-leather upholstering. The ceiling is of light oak, artistically paneled and capped; in the center of the room is a large skylight with handsome figured glass lights. The floor is of red and brown interlocking tile. Just abaft and between the engine casings are baths, lavatories, and a large barber shop. The plumbing throughout was furnished by Alfred B. Sands and Son.

Returning to the upper deck, aft of the boiler casing and forward of the engine casing are the officers' quarters. The officers' mess room is paneled in cherry and ash, with white ceiling, and English carpeting upholstery of neat design. The central station for the electric plant is also located here.

The first-class galley is on the main deck under the pantry. On this deck there is a central passage, about 3 feet 6 inches wide, extending from the second-class pantry on the starboard side of the engine hatch forward to the third-class pantry about under the first-class dining saloon. The galley is on the port side of the passage, and directly opposite on the starboard side is the galley for second and third classes and for officers.

The entrance to the second cabin is at the after end of the main house on the upper deck, between the engine hatches, where a stairway leads to the deck below. On the port side of the engine hatch is the smoking room, with ash side paneling and round air ports and walnut matched wainscoting. The floor is rubber tile and the upholstery of dark-brown pantasote.

The ladies' room is on the starboard side, and has side paneling of sycamore. The ceiling is white staff and the floor is hard wood, covered with rugs. The upholstery is again of dark-red pantasote.

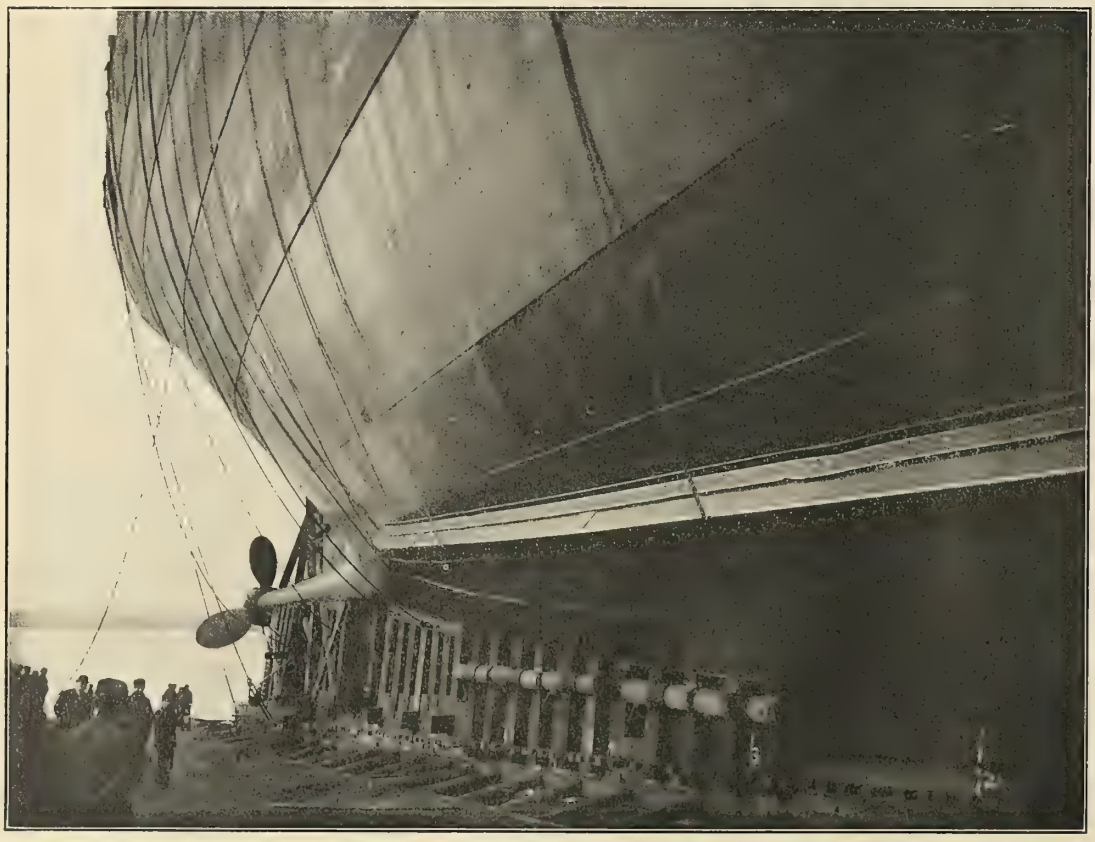
The stairway from the upper deck leads to a small hall. On the starboard side, just aft of the pantry, and running the entire length of the space, is the dining saloon, seating 80 people. This room is finished with side paneling of oak, light finish, and oak furniture. The side lights are circular. The upholstery is of dark-green English carpeting, with lighter green draperies and curtains; the ceiling and beam capping are of white, paneled, and the floor of hard wood. On the port side of the engine casing are a few officers' rooms and be-

NAME—Minnesota. NATIONALITY—American. TYPE—Ocean passenger and freight steamer.
LAUNCHED—1903. BUILDER—East. Shipbldg. Co. OWNER—Great Northern Steamship Co.

Length over all	630 ft.	Launching displacement, about	12,000 tons
" b. p.	608 "	Wetted surface	68,000 sq. ft.
Beam, molded	73 "	Gross tonnage, about	21,000 tons
Depth at side, mid-length	56 "	Net "	15,000 "
" " " lowest point of sheer	54 " 6 ins.	**Propellers,** No. of blades	3 each
" " center	57 " 6 "	Diameter	20 ft. 0 ins.
Block coef	.761	Pitch	22 " 6 "
Prismatic coef	.800	Area, developed	98.7 sq. ft.
Midship sec. coef	.951 ft.	" projected	81.6 " "
Load draft	33 ft. 0 ins.	Weight, each	37.5 tons
Load displacement	33,000 tons	Material	cast steel, both hubs and blades

NAME—Minnesota. NATIONALITY—American. TYPE—Ocean passenger and freight steamer.
LAUNCHED—1903. BUILDER—F. S. Co. OWNER—Great Northern Steamship Co.

Engines, number	two	**Boilers,** number	16
Type	triple 3-crank	Type	Niclausse Water Tube
Cylinder diams	29, 51, 89 ins.	Pressure	250 lbs.
Stroke	57 "	G. S., total	1,080 sq. ft.
I. H. P., estimated	10,000	H. S., "	39,264 " "
R. P. M., "	78	Draft	induced
Speed "	14 knots	Height of stack above grates	124 ft. 10 ins.
Condens. surf. two main,	13,500 sq. ft.	Donkey Boiler	vert. tubular
Valves	H. P. and I. P. piston, L. P. slide	Size	5 ft. diam. by 10 ft. 6 ins. high



FORWARD AND AFTER POPPETS UNDER THE MINNESOTA, READY FOR LAUNCHING.

tween the casing are baths and lavatories. The rest of the space is devoted to state rooms, each room having two berths, a good-sized seat, and a folding cabinet; the finishing is entirely in white.

In the small house just forward of the main house are the petty officers' quarters in the after end, the refrigerating-machinery room in the forward end, and the third-class entrance. A stairway leads to a passage on the main deck which opens into the third-cabin space, which is 48 feet long by the full width of the ship. In the forward end is the dining room, seating 68 people, and in the after end is the pantry, which opens to the passage leading to the galley. State rooms occupy the remainder of the space.

Still further forward is the crew's house, with entrance to crew's quarters on the main and forecastle decks. The house contains a galley for Asiatic crew, a blower, and store rooms.

In the steering-gear house at the after end of the vessel, besides the steering machinery, there is a galley for Asiatic steerage, quarters of laundrymen, blower room; and in the forward end is the laundry. Below, on the main deck, are toilets for steerage, and forward of this, running to the second cabin, is a large space arranged to be used for cargo, troops, or storage. The space forward of the third cabin is also for storage or troops.

GENERAL.

At the time of launching, the *Minnesota* weighed more than 12,000 tons, and the ways necessary for transporting this weight were enormously heavy. The pressure on the fore poppets at the pivoting point was so great that the ground ways below water were built wider, so as to decrease the pressure per square foot. The weight on the fore poppets is estimated at 1,200 tons each. The declivity of the ways is 5-8 inch in 1 foot; the width of each sliding way, 5 feet 4 inches; the inclination of the keel, 1-2 inch in 1 foot; the length of the ways below water from the sea wall is 210 feet.

The launching was delayed for about an hour and a half, owing to trouble in loosening up the blocks under the keel and bilges. When the men began to saw away the sliding ways, so great was the strain on the timber that it snapped in two. The ship started very gradually, giving plenty of time for the sponsor to christen her. She gathered more speed, and in 1 minute 7 seconds she slid the length of the ways ; 55 seconds later the water closed around her bows and she began to settle free from her cradle. Her headway was checked three hundred yards out in the stream by lines from towboats near at hand, and then she cast her anchors and heaved to easily. One peculiar feature, which prevented our photographer from securing a view of the launch, was the smoke that enveloped the bows. The tallow was heated by the weight and friction to such an extent that a cloud of blue smoke arose.

The design of the *Minnesota* and her sister ship has been carefully worked out by President Hanscom and his assistants, and the construction and launching has been under his personal supervision. The *Minnesota* is now being fitted out at the company's wharf, and is expected to be ready for service in the course of the next few months.

THE INFLUENCE OF DEPTH OF WATER ON THE RESISTANCE OF SHIPS.

BY CHARLES P. PAULDING.

There are two important practical considerations under this heading—the limiting economical speed of vessels in shallow water, and the determination of the least permissible depth for the contract trial of a given vessel required to make a given speed. Several articles on the first of these questions have already appeared in Marine Engineering, but possibly the matter is important enough to warrant a little further notice, particularly as this happens to be incidental to a study of the second question.

The data on which these notes are based may be found in a paper read in 1900 before the Institution of Naval Architects by Captain Giuseppe Rota, of the Italian navy; in a paper presented to the same society in 1899 by Captain Rasmüssen, of the Danish navy; and, finally, in a paper read before the International Marine Congress at Düsseldorf in 1902, by Mr. J. Schütte, the engineer in charge of the North German Lloyd Company's model tank. Captain Rota and Mr. Schütte experimented with models about 12 feet in length, in well-equipped model tanks; Captain Rasmüssen, on the other hand, made his experiments with a torpedo boat of 132 tons displacement.

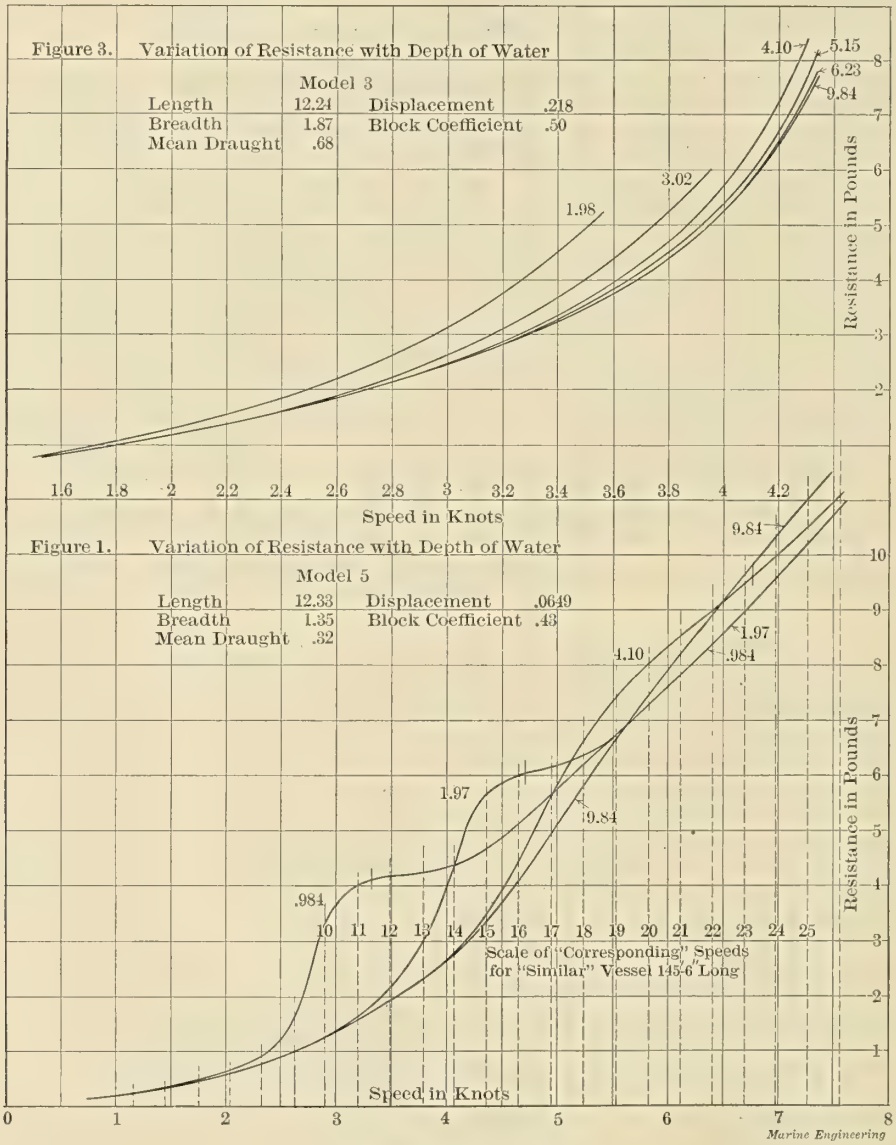
The curves of the original papers have been redrawn to a large scale of English units before reproduction here.

Fig. 1 gives the resistance curves of a torpedo-boat model, and near each curve is a figure showing the depth of water in feet in the tank during the determination of that particular curve. Attention is called to the pronounced humps in the curves and to the relative position on these humps of the short vertical lines marking the limited speed of a wave of translation in that particular depth of water. As explained in Mr. Stevens' article, this speed is determined by the formula $v = \sqrt{gh}$, where v is the speed in feet per second and h the depth in feet. Above this point the usual wave system is unable to keep pace with the boat and the wave-making resistance is consequently very much diminished. This abnormal increase of resistance takes place at the same speed, regardless of the size of the vessel, although its amount varies greatly with different vessels or with the same vessel at different displacements. All this was fully brought out in the previous articles, but what should be emphasized here is that the wave speed is considerably above the economical limit, in fact for any but torpedo boats it is above the possible speed of a vessel, and if any regard is to be had to economy we must be content with a speed nearly, if not quite, two knots less. A study of Figs. 1, 2, and 4 will make this sufficiently obvious.

In Fig. 2 the dotted curves represent Captain Rasmüssen's experiments, while the full line curves show the approximate horse power, for a torpedo boat, derived from the model curves of Fig. 1. It is to be noted that, while the boats are of the same length, their displacements differ greatly, and it naturally follows that the powers are quite different. The wave speed corresponding to the depth is marked on each curve as in Fig. 1. Only one curve for the *Söbjörnen* is of such shape as to conspicuously show the relative position of

this wave speed; it may be taken as thoroughly characteristic, since a number of other experiments by this same officer show the same thing. Now, the curves for the derived vessel show the same position of the wave-speed mark relative to the hump in the resistance, and are precisely what we would expect from the *Söbjörnen* if she had been run at these depths, except that the increase of resistance is much smaller. Rasmüssen showed theory that for vessels of the same model, at corresponding speeds, the depth of water affected by their motion is directly proportional to their linear dimensions, it is not a point which has been much dwelt upon.

Before proceeding to the second part of the subject, the least depth of water at which a vessel may be run without perceptible increase of resistance, it will be well to briefly consider the method of estimating the re-



FIGS. 1 AND 3.

that the power necessary at this point was greatly influenced by even a small change of displacement, and we have here a very large change and different proportions besides. The qualitative resemblance is the important one in our comparison, not the quantitative one, and we are evidently able to make very useful predictions in regard to a ship in usual depths of water from the tank experiments with a 12-foot model.

Perhaps an apology is due, in this age of model tank experiments, for supposing that anything else could be the case; but although it is an integral part of Froude's sistance of a ship from the results obtained by towing a model in an experimental tank, taking for an example the derivation of the full line curves of Fig. 2 from those of Fig. 1. The length of the model is 12.33 feet; the length of the derived vessel is determined here by the necessity, for the purpose in hand, of having it the same as that of the *Söbjörnen*, namely, 145.5 feet. The scale of ship to model is therefore 145.5 ÷ 12.33, or 11.8. All linear dimensions of the ship are found, then, by multiplying the corresponding dimensions of the model by 11.8, the wetted surface by multiplying by the square

of 11.8, and the displacement by multiplying by the cube of 11.8. Now, Froude showed, by mathematics and experiment, that when a ship and its model are driven at speeds connected by the ratio $\frac{\sqrt{\text{length of ship}}}{\sqrt{\text{length of model}}}$ the wave-making resistances are in the ratio $\frac{\text{displacement of ship}}{\text{displacement of model}}$,

we find the formula with the numerical coefficients appropriate to this length of model in fresh water to be;

Resistance in pounds

$= f \times$ wetted surface $\times$ (speed in knots)^n

$= .009 \times 15.95 \times$ (speed in knots)$^{1.94}$

In this case we had to estimate the wetted surface of the model, but for our purpose the error thus introduced, though possibly quite large, is immaterial. By the above formula we draw on Fig. 1 a curve of frictional resist-

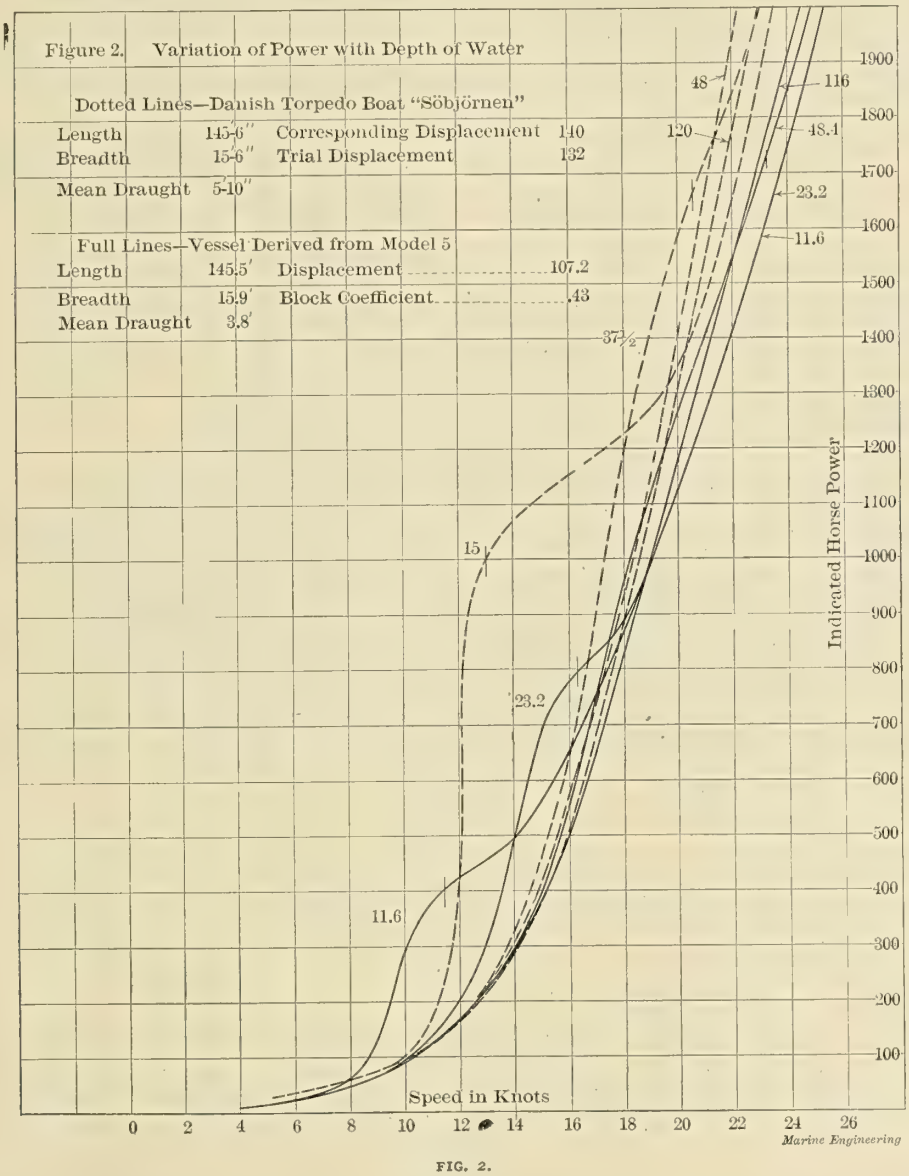


FIG. 2.

or, in other words, for speeds in the ratio of the square root of the scale of ship to model the wave resistances are in the ratio of the cube of the scale. The frictional resistance follows no such law and must be computed separately for ship and model. In Fig. 1 we have the curves of total resistance for the model, and to determine the wave-making resistance—and it must be remembered that it is this resistance that introduces so much uncertainty in our estimates of the resistance of ships—we must calculate by means of Froude's tables the frictional resistance. From Taylor's *Resistance of Ships* ance (not shown). At four knots, for example, this amounts to 2.11 pounds. At any speed the vertical distance between this curve and the curve of total resistance represents the wave-making resistance, but in extending these wave-making resistances from model to ship we must remember that they are only connected at corresponding speeds. Thus a speed of four knots for the model corresponds to $4 \times \sqrt{11.8} = 13.73$ knots for the derived vessel, and to simplify this part of the work we lay down on Fig. 1 a scale of corresponding speeds for the derived, or "similar," ship. It only remains to com-

pute the frictional resistance of the ship. Referring again to the tables in Taylor's *Resistance of Ships*, we get for a clean steel vessel of this length in salt water:

Resistance in pounds

$= .0096 \times 2220 \times (\text{speed in knots})^{1.83}$

Take, for example, the ship at 13.73 knots, corresponding to four knots for the model; the frictional resistance of the model we have already found to be 2.11 pounds; the total resistance at four knots for the curve obtained in .984 foot of water we see on Fig. 1 to be 4.32 pounds; then the wave-making resistance is 4.32 — 2.11 = 2.21 pounds, and the wave-making resistance of the ship at 13.73 knots will be $2.21 \times 11.8^3 = 3{,}632$ pounds. The

of a model of the dimensions given on the figure. Suppose that we wish to know the least depth in which a cruiser of the *Denver* class, now nearing completion for the navy, can be driven at the contract speed of 16.5 knots without "feeling the bottom." The cruiser's dimensions and those of a vessel of the same length derived from the model are as follows:

	Denver	Vessel derived from Model 3.
Water-line length	292 ft. 0 in.	292 ft.
Breadth	43 " 3¼ "	44.5 "
Draft	15 " 9 "	16.25 "
Displacement—tons ...	3,200	3,000

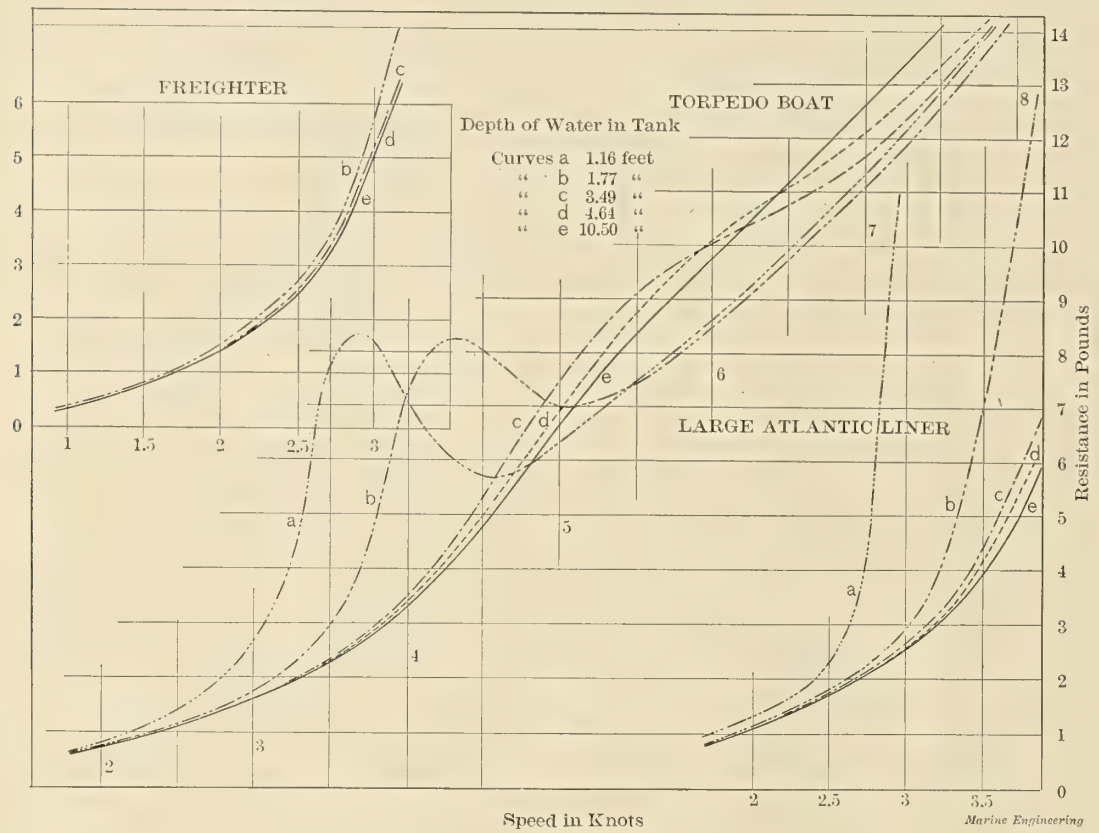


FIG. 4.

frictional resistance of the ship we find from our formula to be 2,573 pounds; then the total resistance is 3,632 + 2,573 = 6,205 pounds, at 13.73 knots. The corresponding horse power is 6,205 × 13.73 × .00307 = 262, and assuming a propulsive coefficient of .55 we have 477 indicated horse power.

The figures for depth of water near the full line curves of Fig. 2 are obtained from the corresponding figures in Fig. 1 by multiplying by 11.8, because it is a fundamental part of Froude's theory that the stream lines around similar vessels are similar and differ only in scale; therefore the effect of the bottom when one foot below our model would be the same as the effect of the bottom 11.8 feet below the ship.

We are now in a position to draw some useful conclusions from the model tank experiments; turning to Fig. 3, we have the resistance curves at different depths

The agreement is sufficiently close for our purpose. Since the scale of ship to model is 23.9, the model speed corresponding to the *Denver's* 16.5 knots is $16.5 \div \sqrt{23.9} = 3.38$. Referring to Fig. 3 we see that 6 feet is about the smallest depth for that speed consistent with no increase of resistance. The corresponding depth for the *Denver* would be 6 × 23.9, or say 150 feet. A similar calculation for the *St. Louis* class, length 424 feet, contract speed 22 knots, gives a depth of 200 feet; and for the *Tennessee* class, length 502 feet, contract speed 22 knots, the depth works out at 230 feet.

At a depth of 95 feet the *Denver* would, at 16.5 knots, experience an increase of resistance of about three per cent., at 72 feet an increase of about twelve per cent.

The steam yacht *Niagara* has a water-line length of 248 feet; if she were able to steam at 17 knots she would require a depth of 125 feet. The *Dreamer*, 149 feet long,

would require 120 feet at 15 knots. It seems strange that the smaller vessel at lower speed should require practically the same depth of water, but it must be remembered that the increase of resistance is entirely an increase of wave-making resistance, and that a 149-foot boat at 15 knots is experiencing much greater proportionate wave-making resistance than a 248-foot boat at 17 knots. The 502-foot *Tennessee* could steam 15 knots in this same depth without feeling the bottom.

The curves of Fig. 3 are suitable for cruisers, for yachts, and for finely-modeled passenger steamers of moderate size. From experiments (Rota's) with a model resembling fairly closely a battleship of the *Georgia* class, it would appear that the depth obtained from Fig. 3 needs, at 19 knots, to be increased about ten per cent., giving a corrected depth of 200 feet.

Turning now to Fig. 4, which represents Schütte's experiments, we find the resistance curves from the models of a very large Atlantic liner, a large freighter, and a torpedo boat. The principal dimensions of the models are given in the following table:

	Freighter	Tpdo. boat	Liner
Scale of ship to model.....	40	17.5	45
Length in feet.....	13.07	11.42	14.12
Breadth in feet.....	1.500	1.292	1.464
Draft in feet.....	.645	.346	.582
Displacement in tons.....	.2612	.0643	.2052
Wetted surface in sq. ft.....	29.85	14.09	26.35

The model of the liner was made to represent a ship 635 feet long and of about 19,600 tons displacement; at a speed of 23 knots the corresponding model speed would be 3.4 knots, and from the figure we may say that at least 6 feet of water are required, and for the ship this becomes $6 \times 45 = 270$ feet. It is interesting to note that curve *a* represents roughly the conditions of resistance for this vessel steaming from the bar to Quarantine. Under these circumstances her full power would barely drive her at 18 knots. The wave formation along the sides of one of these great vessels, in the shallow water of the lower bay, when it is making every effort to reach Quarantine before sunset, is a sight not to be forgotten.

The model of a freighter represents a ship 523 feet long and of nearly 17,000 tons displacement; at 14 knots the model speed would be 2.2 knots and curve *c* would give the requisite depth, namely, $3.49 \times 40 = 140$ feet.

These very considerable depths of water for minimum resistance are confirmed by the practice of the navy, where all vessels of any size are taken well out to sea for their acceptance trials.

Mr. Schütte also experimented with a deep but narrow channel of variable width, and the results showed that the torpedo boat needed a width of channel of about fifteen times her own breadth, the liner about twelve times, and the freighter six times. With narrower channels the resistance was seriously increased, although the increase was neither so rapid nor so great as with shoaling of the water. The curves for the torpedo boat at very high speeds fell below the normal curve very much as they did in shallow water.

THE WRECKED BRITISH TORPEDO-BOAT DESTROYER ORWELL.

Wrecked Torpedo Boat.

The cut herewith presented, and reproduced from the *Illustrated London News,* shows the British torpedo-boat destroyer *Orwell* after colliding with *H. M. S. Pioneer* on the night of January 30. The accident occurred during night manœuvers in Corfu channel, when the destroyer was steaming at about 15 knots to a rendezvous outside the area of operations to await further instructions. The *Pioneer,* showing no lights whatever, suddenly approached, and, before anything could be done to avert a collision, she had crashed through the port side of the *Orwell,* cutting through at an angle of about 30 degrees and completely severing over 40 feet of her bows. Two officers and thirteen petty officers and seamen were killed and drowned by the collision. The engine-room department sustained no loss, and it is stated the engines are not injured. The vessel was towed to her moorings and berthed alongside the cruiser *Trine.*

The *Orwell* is a 30-knot destroyer, built in 1898 by Laird Bros., and is fitted with Normand boilers. She carries a crew of sixty men.

AN OLD WRECK BURIED IN THE SHIFTING SANDS OF CAPE COD.
[Photograph by T. E Marr, Boston, Mass.]

WRECKING WORK OF THE BOSTON TOWBOAT COMPANY.

BY WINTHROP L. MARVIN.

There may be coasts as dangerous as that which stretches in alternating rock and sand from Nova Scotia to Long Island sound, but there are few whose waters bear such a heavy commerce, conducted in fair weather or foul, in snow or rain or fog or sunshine, the whole year around. It is not strange that with so great a traffic on so hazardous a road there should be occasional disasters; this is the inevitable price of navigation. But, though the risk is large all along this bold seafront of New England, the means of saving life and property are proportionate. The national government has elaborately lighted and buoyed this northern coastline, and private enterprise provides abundant facilities for the prompt rescue of valuable ships that go ashore.

With headquarters at the chief New England port, in the very center of this long seaboard, the Boston Towboat Company, of which Mr. Alfred Winsor is president, Capt. William F. Humphrey treasurer, and Mr. Thomas I. Winsor manager, watches every mile of the coast through its agents in every ocean village. South of Cape Cod, in the convenient harbor of Vineyard Haven, the company maintains a separate station, with a wreck-master and diver, a large lighter, six steam pumps and boilers and other paraphernalia, and through the winter months a powerful tug, for the relief of a distressed vessel or cargo anywhere along the range of Vineyard and Nantucket sounds.

At the head of its wrecking fleet the Boston Towboat Company possesses a large ocean-going steamer, the *Orion,* with one-third more steam power than is usual in vessels of its class, and equipped with a patent towing apparatus—a reel controlled by steam cylinders. This apparatus is employed to pull off unfortunate vessels that have grounded. A wire cable and a manila cable are used together, so arranged that the first strain comes on the relatively elastic manila. When this is stretched nearly up to the limit of its tension, the steel cable in turn "takes hold," and it must be a very firmly rooted craft indeed which will not come off under this formidable persuasion. To prevent still further the wasteful breaking of cables, the reel is so adjusted that when a certain strain is reached the apparatus automatically unwinds.

Next in importance in the company's wrecking fleet comes the big, full-powered wrecking tug *Underwriter,* originally built by the marine underwriters of Boston to protect their interests on the New England coast, and afterward purchased by the towboat company. She is maintained constantly in first-class order, ready for any call, and has saved many a good ship and cargo from destruction. Besides the *Underwriter* there are two other large wrecking tugs, the *Storm King* and *Mercury,* and 18 other tugs for bay or harbor service, with 23 lighters of all kinds, including three distinctively wrecking lighters, the *Aid, Oak,* and *Salvor.* The wrecking apparatus includes 16 modern centrifugal pumps, pontoons, anchors, cables, blocks, chains, etc., all of which must be kept prepared for any emergency. The company employs three experienced wrecking divers.

Not only does the Boston Towboat Company successfully conduct the coast wrecking business of New England, but many of its achievements have taken place far from home. When in March, 1894, the historic sloop-of-war *Kearsarge* crashed to her inglorious doom on the merciless reef of Roncador in the Caribbean, it was this Boston company which was chosen by the government to fit out the expedition of rescue—and it is no fault of the company that the plan did not succeed. The *Orion,* with a strong crew and ample apparatus, was promptly sent southward, but before she could complete her long voyage the *Kearsarge* had been robbed and burned by Caribbean pirates, who flocked to the spot like a

A CREW OF BRAVE LIFE SAVERS; THE SURFMEN OF ONE OF THE CAPE COD STATIONS.
[Photograph by T. E. Marr Boston, Mass.]

crowd of vultures at the first news of the disaster. The *Orion* had to content herself with bringing home some parts of the equipment and a few relics of the gallant conqueror of the *Alabama.*

Once again, in June, 1897, the *Orion* steamed far down the southern seas to rescue the British tramp *Ethelgonda,* from Argentina for Boston, which had gone ashore on St. Lucia with a cargo of wool valued at several hundred thousand dollars. The unlucky ship lay on the windward side of the island, in an exposed position, right in the midst of a furious surf. She had settled so far that half of her cargo was submerged, but the other half of the wool was dry. The *Orion* anchored about a mile away from the *Ethelgonda,* in safe water, and brought the dry wool off in native pirogues whenever the weather permitted. In this way half of the cargo was saved, and then the *Orion,* with full holds, returned to Boston. As soon as she left the wreck her sister ship, the *Saturn*—sold a year later to the Navy Department as a collier in the Spanish War—was dispatched to the *Ethelgonda.* Steam pumps were put aboard the helpless vessel and the holds were freed of water. Then the powerful *Saturn*—equipped, like the *Orion,* with a patent towing apparatus—succeeded by "jumping" in hauling the *Ethelgonda* off the reef, and brought her into the shelter of Port Castries. There the wet wool was unloaded and dried. These Yankee wreckers were not, however, yet through with their undertaking. They took the floated ship over to Martinique, put her into dry-dock, made temporary repairs, and then crossed the ocean and delivered her safe in Liverpool. This extraordinary wrecking task, begun in June, was not completed until October.

Still again, the *Orion* went down to Barranquila, near Colon, on the Isthmus of Panama, to the stranded Norwegian steamer *Fri,* pulled her off, and towed her to New York. In February, 1898, it was once more the Boston Towboat Company which was selected by the government to go to the rescue of a national ship. An expedition was sent out from Boston to the shattered *Maine* lying in Havana harbor. But the battleship—the tomb of 266 brave men—was of course found to be a hopeless wreck and not worth raising. In October, 1902, this company was called to Havana on a very different mission—to tow from there to our navy yard at Pensacola the Spanish floating dry-dock which had passed into the possession of our government.

One especially difficult task of wrecking was that attempted when the Belgian steamer *De Ruyter* was driven ashore on the dreaded ledges of Scituate in March, 1890. The Boston Towboat Company sent down some of its most powerful apparatus, and managed to get the heavy ship afloat, but the steam pumps could scarcely keep the broken hull free, and the *De Ruyter* came very near foundering before she was dragged into Boston harbor.

Another and a still more difficult exploit was the saving of the Cunard steamer *Pavonia,* on the same perilous coast, in November, 1896. Inward bound in misty weather, the *Pavonia* sighted a rocky headland which her captain took to be Nahant. Accordingly he shaped his course southward to reach Boston light. Although he was warned by passing boats of his peril, this Briton, with true insular conceit, kept on his blundering course through the fog until he suddenly brought up "all standing" against the reefs and bars off Marshfield. Of course, the *Pavonia* was badly wrecked and torn, but the wreckers, coming promptly to the rescue, managed to drag her off the rocky bottom and to bring her up off Boston light, where the ship was anchored in the darkness and a heavy sea and wind, the pumps desperately working to keep down the inrushing water. But, as it was feared that the ship would sink with her passengers, who were still on board, she was brought, by skillful and daring navigation, inside the Nantasket roads, where her forefoot settled on a soft and friendly bottom and she and her people were safe.

When the Leyland liner *Venetian,* outward bound for Europe, struck State ledge and sank in Boston harbor in March, 1895, the Boston Towboat Company took all the cattle off in five hours, before the tide could return and drown them. As for the old ship, she was slowly broken up for junk. Very much more fortunate was the Warren liner Norseman, inward bound from Liverpool, which lost her reckoning and suddenly drove up hard and fast on the jagged ledges of Marblehead neck in March, 1899. This was an exposed locality, and the ship was seriously damaged, but in twenty days of strenuous labor the Boston wrecking fleet succeeded in getting the *Norseman* once more into her proper element. First the cargo was lightered. Then a big hole in the bow was patched, and the water in the hull was

THE BRITISH SHIP NORSEMAN ON THE ROCKS OFF MARBLEHEAD, MASS.
[Photograph by T. E. Marr, Boston, Mass.]

reduced by pumps until the tugs managed to pull the great ship off the rocks and into Marblehead harbor. There a diver patched up, as is well illustrated in the accompanying engravings, the mutilated bottom, which could not be reached so long as the *Norseman* rested on her rough bed of boulders and ledges. Then the Warren liner was ready for bringing to Boston.

This is the customary process in the wrecking operations of the Boston Towboat Company: Just as soon as a wrecked ship is floated she is hurried into the nearest harbor for temporary repairs. If there is a dry-dock there, well and good; if there is none, resort is had to the slower and less complete but useful methods of the divers. If the ship now floats with about eight feet of water beneath her keel, the bold men in the diving suits can get at the injured bottom quite handily and stop the worst leaks. Sometimes these can be reached and remedied from the interior.

The great November gale of 1898, in which the side-wheeler *Portland* went down with all on board, wrought several wrecks within the sheltered area of Boston harbor. The big Reading tug *Tamaqua,* drawing 15 feet of water, was driven away up on Rainsford island. Next day, when the storm tide subsided to the normal, only five feet of water were left around the unlucky tug. It was obvious that no ordinary wrecking methods would meet this difficulty, so a dredging machine was resorted to, to dig out the *Tamaqua,* and also dredge a channel over two miles long to free the lake steamer *John J. Hill,* which had been forced by the same terrific storm away up on the shallow shore of Wollaston.

In recent years the Boston Towboat Company's wrecking outfit has released the Savannah liner *Gate City* and the Clyde line steamship *Cherokee* from the too close embrace of Naushon, dragged the badly injured United Fruit steamer *Admiral Dewey* off the savage ledges of Cuttyhunk, raised the harbor steamer *Mayflower,* sunk in collision, pulled the Boston-Philadelphia liner *Spartan* off the Jersey beach, and floated the Plant steamer *Halifax* from an uneasy bed under the ramparts of Fort Warren. This same energetic company has lifted from the bottom two heavy sunken coal barges, the *Atlas* and the *Felix.* When the sloop-of-war *Galena* and the tug *Nina,* bound for Portsmouth, went

ashore together on Gay Head, it was the Boston wreckers who restored these ancient craft to the national service, and boats and men of the same company saved the sailing ship *Gov. Robie*, the barks *Albertina* and *Western Belle*, and the schooner *Andrew Adams*. One notable piece of far-away work was done when the steamship *Britannia*, wrecked on the Nova Scotia coast, was rescued and conveyed to Halifax and thence to Boston. And all this is an enumeration of only a few of the cases in which the company has come out victorious in its constant battles with the ocean.

The Metropolitan steamer *Henry M. Whitney*, outward bound, was struck a terrific blow in Boston harbor in September, 1892, by the incoming Liverpool liner *Ottoman*. A hole large enough for a tally-ho coach to drive through was torn in the *Whitney's* steel side, and

HOLES IN THE BOTTOM OF THE NORSEMAN, SHOWING TEMPORARY REPAIRS MADE BY DIVERS WHICH ENABLED THE SHIP TO BE BROUGHT INTO PORT.

the wounded ship sank on the instant. Divers were sent down and stopped the huge leak, patched the decks, and lifted the *Whitney* out of the depths of the busy channel to the East Boston repair dock.

When the lighthouse supply steamer *Armeria* went ashore in Penobscot bay in the summer of 1897, she drove at high tide on a lone or pinnacle rock abaft of amidships. Now the tide rises and falls a dozen feet or more in Penobscot bay, so when it went out it left the vessel suspended, as it were, on a pivot, with her bow deep down in the brine and her stern, rudder, and propeller far out of the water. The weather was fair and the *Armeria* had a good, strong American steel hull, so she hung together until the towboat company brought of labor, they got the *Wilster* afloat on March 27 and saved half of her cargo. The bottom of the ship was fairly corrugated by so many days of rolling and pounding on Cape Ann rocks, and the requisite repairs made the *Wilster* so much of a Yankee ship that she was admitted to our registry and now flies the Stars and Stripes above the good Yankee name of *Dorothy*.

An achievement of which the Boston Towboat Company is even prouder, and justifiably so, is the saving of the fine Boston-Philadelphia liner *Indian* from the reefs near Cuttyhunk, known as the Sow and Pigs, reputed to be the graveyard of every ship that ever struck there. This case of salving was also illustrated and described in Marine Engineering, August, 1902. The *Indian's*

THE STEAMBOAT MAYFLOWER, SUNK BY COLLISION.
[Photograph by T. E. Marr, Boston, Mass.]

down its pontoons from Boston. They were skillfully attached to the ship at low water, and when the Penobscot tide came in it lifted the handsome ship off uninjured.

Still later rescues are those of the Allan liner *California,* ashore near Portland harbor in February, 1900, and the *Massapequa,* only a few months ago, on the south shore of Massachusetts. Another noteworthy exploit carried out by this company and described in these pages in the April and July, 1902, issues, was the saving of the British steamer *Wilster.* This almost new and valuable vessel, with a rich cargo of 3,000 tons of bag sugar, struck among the boulders of Pebble beach, Rockport, Cape Ann, February 28, 1902. Five successive gales of wind drove the wrecking craft away from their work, but they kept on undaunted, until, after a month bottom plating was badly smashed and her lower hold filled with water, when the ingenious expedient was resorted to of floating the ship off on her lower deck. The hatches were heavily planked over, calked, and shored, and the deck itself was shored down to resist the terrific pressure. Fifteen centrifugal pumps were set to work, and the ship was finally lifted off the ledges and towed into Vineyard Haven. It is said of the Cuttyhunkers, who have lived for years off the spoil of wrecks, that they declared among themselves that they would quit their island if the *Indian* was saved! A year or two before the Merchants' and Miners' steamship *Fairfax* had gone ashore nearby, and her bones are rusting among the ledges.

As to the *Massapequa,* she went ashore at Marshfield last February at high water. Before another high water

the towboat company's tugs had fastened to the vessel, and at the flood they pulled her off. Within five hours thereafter a heavy gale came on, which would have proved sure destruction to the vessel if she had remained.

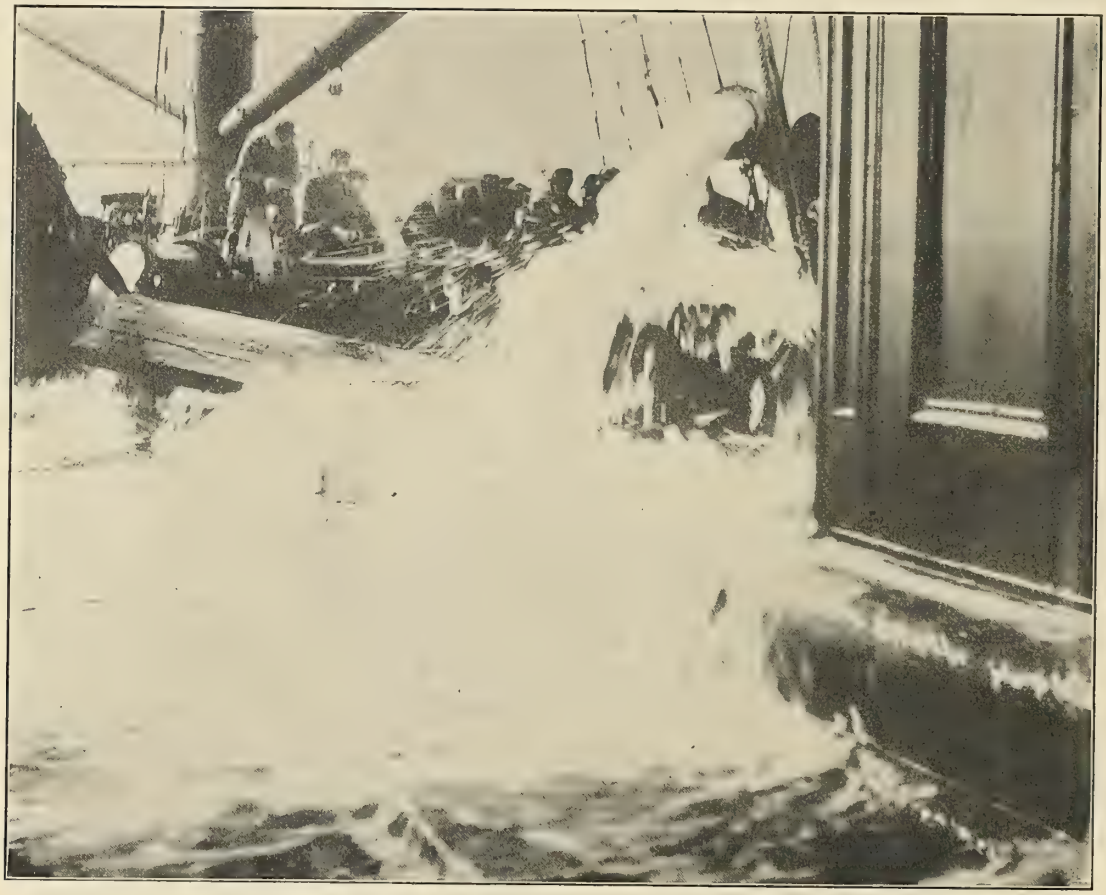
The centrifugal wrecking pumps, of which the company has sixteen, are in general of the 8-inch type, which have been found to be as large as it is convenient to handle. These pumps are driven by steam at a pressure of about a hundred pounds, and they have a capacity for from 2,500 to 3,000 gallons of water a minute. On the *Indian* fifteen of these pumps were in operation at one time. One of the steam boilers which the lighters carry can work two pumps, if fresh water is available. But one boiler is required to run one pump if, as often happens, the only water to be had is the briny liquid right from the ocean alongside. Each of the wrecking lighters of the Boston Towboat Company carries two boilers and four pumps, and there are half a dozen pumps always in reserve at the company's station in East Boston. The portable boilers by which these pumps are operated weigh about four tons each. Under certain conditions steam is sometimes supplied to the pumps through hose from tugs lying alongside the wrecked vessel. The derricks of the wrecking lighters can lift about fifteen tons, but the heavy lighter *Bull* is capable of handling fifty tons.

Such an ocean wrecking business as that carried on by this company demands fine sailor-like skill and manly hardihood. It is a trade of large risks and heavy expenditures. The mechanical and engineering problems are often sudden, unforeseen, and bewildering except to men of dauntless pluck and long experience. Up to twenty-five years ago the extraordinary hazards of the calling were frankly recognized, and a wrecking company was employed by the day and paid whether or not it was successful. But the underwriters finally objected to this practice and insisted on the principle of "no cure, no pay." For twenty years or more, therefore, the reward of a wrecking operation has been contingent on success. The saving of the *Indian* last year, for instance, required sixty days. If on the fiftieth day a gale had come along, it might have meant the instant, absolute waste of all the time and money that had been spent by the company upon preparing to float the ship, or fully $60,000.

DREDGING OUT THE JOHN J. HILL, BLOWN ASHORE IN A HURRICANE.
[Photograph by T E. Marr, Boston, Mass.]

Sometimes the wrecking company may strike what seems to be a bit of easy good fortune—as when in March the *Underwriter* and *Storm King,* dispatched from Vineyard Haven to the British steamer *Parkgate,* ashore on Nantucket shoals fifteen miles east southeast from Sankaty head, found the steamer already afloat when they reached her, and had only to pilot her out of the labyrinth of sandbars. But it ought to be remembered that in the thick, rough weather prevailing it was difficult and hazardous for the tugs to venture among these shoals, shifting with every storm and out of the usual paths of navigation, and, moreover, that the company is constantly maintaining at Vineyard Haven at heavy cost these resources of so much benefit to

commerce and humanity. The *Parkgate,* though afloat and anchored, lay in the midst of dangerous shoals from which she could not have escaped without assistance. But for the guidance of the two tugs, that were in frequent peril themselves, the *Parkgate* would unquestionably have shared the fate of the steamship *Canonbury,* which struck near the same spot in March, 1888, and was lost with her cargo—of a total value of $292,000.



WRECKING PUMP IN SERVICE ON THE SUNKEN STEAMSHIP DE RUYTER.

A Special Trim Calculation.

BY B. A. SINN.

As ships grow larger, the question of stability and trim becomes one of not nearly as great moment as in the smaller ships of some years ago, principally owing to the fact that the greater length, beam, and draft produce a much higher metacenter, and that the machinery, which is situated well down in the hold, and which forms a large part of the total weight, has a large negative arm which tends to reduce the center of gravity. This in effect produces a longer stability arm and a stiffer boat and consequently less motion due to rolling and pitching. Our modern steamers are therefore much more stable than those of former years.

The modern naval architects have consequently little to fear as long as the vessel is intact and under normal trim conditions. However, special cases may demand such arrangement of the interior as to make the vessel seem dangerous at first sight, if damaged or under circumstances of unstable equilibrium. Such a case passed under the writer's notice some two years ago, where, owing to an arrangement of hatches and holds, made necessary by the special cargo to be carried, a vessel of 500 feet length, 58 feet beam, and 40 feet molded depth had a forehold of over 120 feet in length, and the question as to the trim of this boat under a damaged or flooded condition of this hold made the calculations here shown necessary.

A careful figure of the center of gravity longitudinally was made and Bonjean curves drawn out and plotted, then curves of buoyancy for 16, 18, and 20-foot draft calculated, drawn as shown in Fig. 1. By cutting out a distance of length equal and in the position of the No. 2 hold, and integrating the residual, a displacement curve was drawn which showed the displacement at varying drafts with No. 2 hold flooded. Metacenter and center of buoyancy calculations were also made and the results plotted. As the displacement was known, it became an easy matter to find the corresponding draft and longitudinal center of buoyancy and metacenter from these curves. As the center of gravity was unchanged, and the center of buoyancy, displacement, and metacenter known, an approximation of the trim could be made. These figures showed a mean draft of 21 feet 3 1-2 inches and a trim of approximately 12 feet.

We now knew the limits of change, and, in order to arrive at more accurate results, we plotted from the Bonjean curves curves of sectional areas with about 5, 10, and 15 feet trim and for from 20 to 24 feet mean

draft. These are shown in Fig. 2. Then by integrating these curves with No. 2 hold flooded and plotting the same, we have, as shown in Fig. 3, the range of displacement from 8,400 to 11,000 tons, and by figuring the centers of buoyancy we plot curves in three planes with variable trim, displacement, and centers of buoyancy.

By drawing a straight line from a point equal to 9,448 tons displacement (the condition of load presupposed), we immediately find, at the intersections of this line with the displacement and variable trim, points which in turn were plotted in Fig. 4.

At the point of intersection of a perpendicular in Fig. 4, at the center of gravity and the variable trim line we find that the center of buoyancy and center of gravity coincide when the vessel trims 12.67 feet by the head.

From Fig. 3 we see that the corresponding draft of 9,448 tons is 22.07 feet mean, which, with 12.76 feet trim, would bring her down to 28.45 feet forward and 15.69 feet aft. In this case at first sight it would seem that the vessel was in a precarious condition with the large hold flooded, and the first thought would be to affect the design of the vessel in some way to subdivide these large spaces. Further investigations show, however, that the vessel would not be further in the water at the stem under these conditions than she would be under ordinary load, consequently the vessel would be in no danger of foundering, and, further, if the three forward water-bottom tanks are pumped out, the trim becomes negligible, being less than 3 feet by the head.

Had these calculations not been made, a lengthy discussion between underwriters, shipbuilders, and shipowners would undoubtedly have occurred when the vessel was finished; as it is, it is clearly shown that in this particular case there is no danger. However, it is not to be assumed that this will generally hold for vessels of this size, and an accident to the forward collision bulkhead, which would fill the forward forepeak tank and No. 1 hold, will place the vessel in a far more dangerous condition, as the moment would be larger, although the body of water affected much smaller.

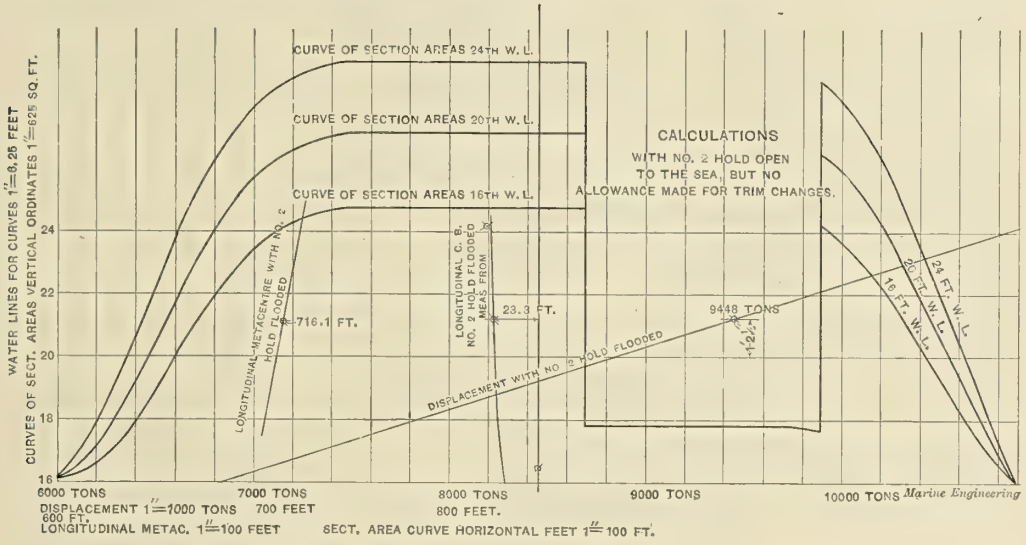


FIG. 1.

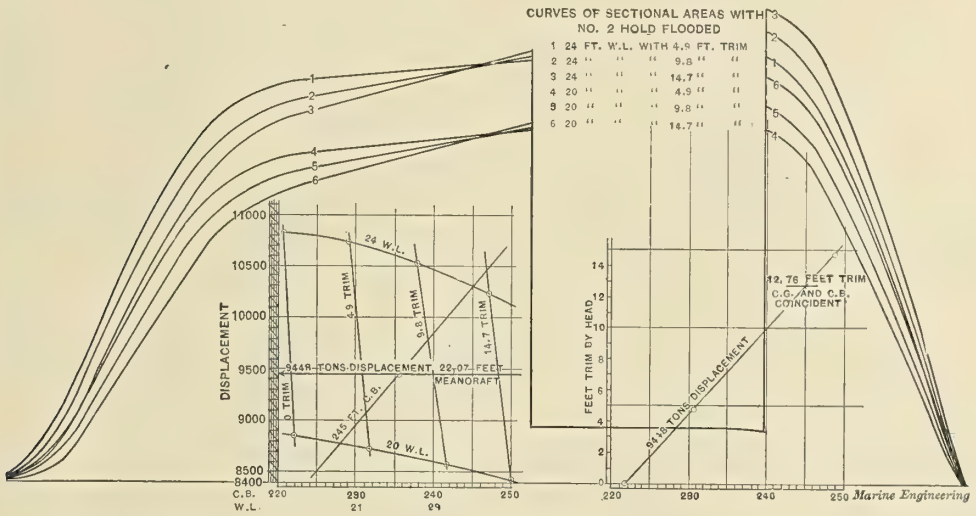
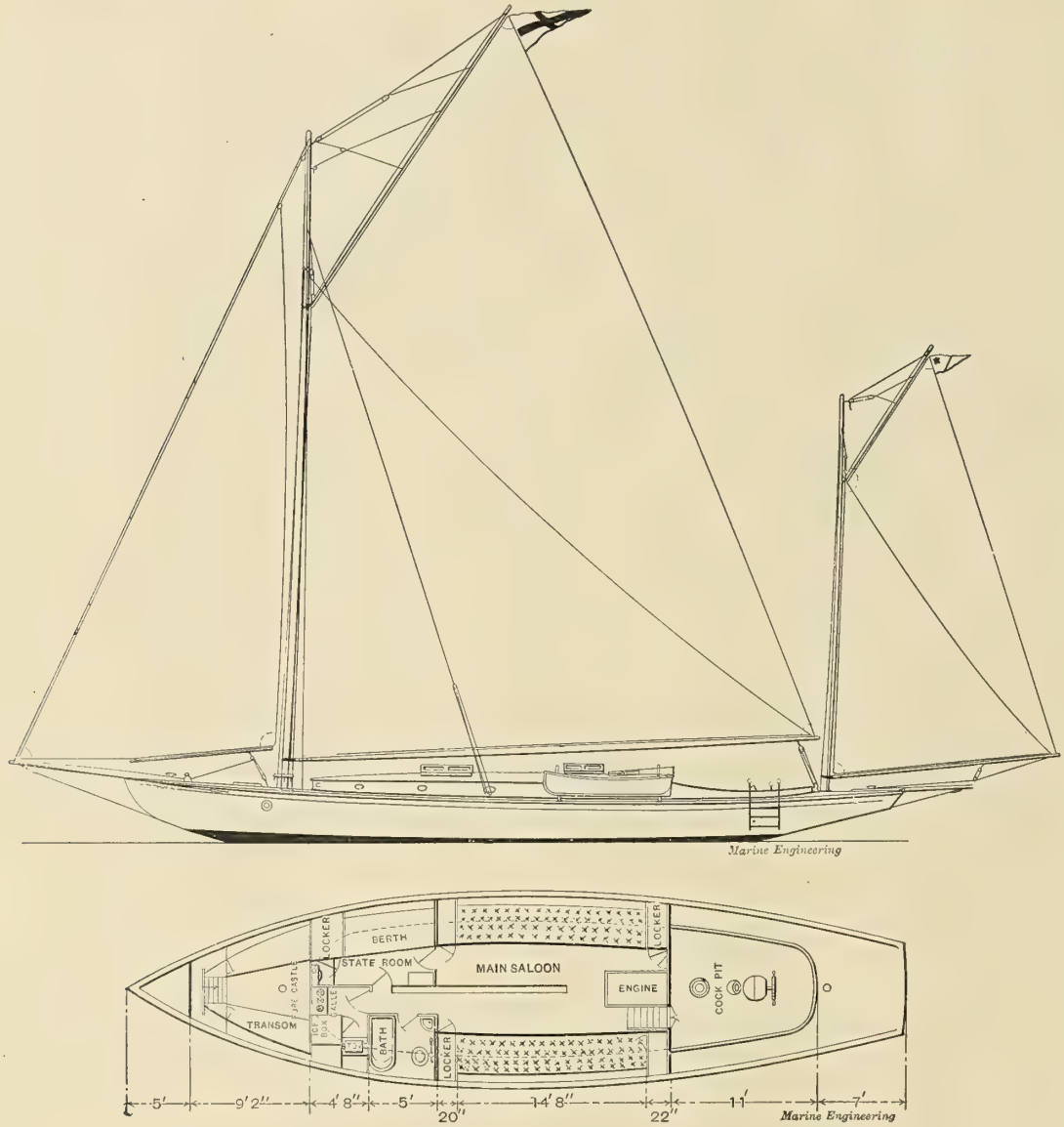


FIG. 2. FIG. 3. FIG. 4. FIG. 2.

Under these circumstances the trim by the head would not be dangerous, except, in the case of a very severe storm, if a large quantity of water were to come down through the holds which would render the vessel unmanageable; but the modern steamers with deep tanks and water bottoms are so easily trimmed that ordinary caution is all that is necessary to keep them constantly safe in a transatlantic voyage.

Length and diameter of mast	51	ft. x 9 in.
Length and diameter of main boom	41	" x 5 "
Length and diameter of gaff	28	" x 4 "
Length and diameter of jigger mast	31½	" x 7 "
Length and diameter of jigger boom	18	" x 3 "
Area of mainsail	1,376	sq. ft.
Area of jigger	337	" "
Area of jib	398	" "



SAIL AND CABIN PLANS OF A SIXTY-FOOT AUXILIARY YAWL.

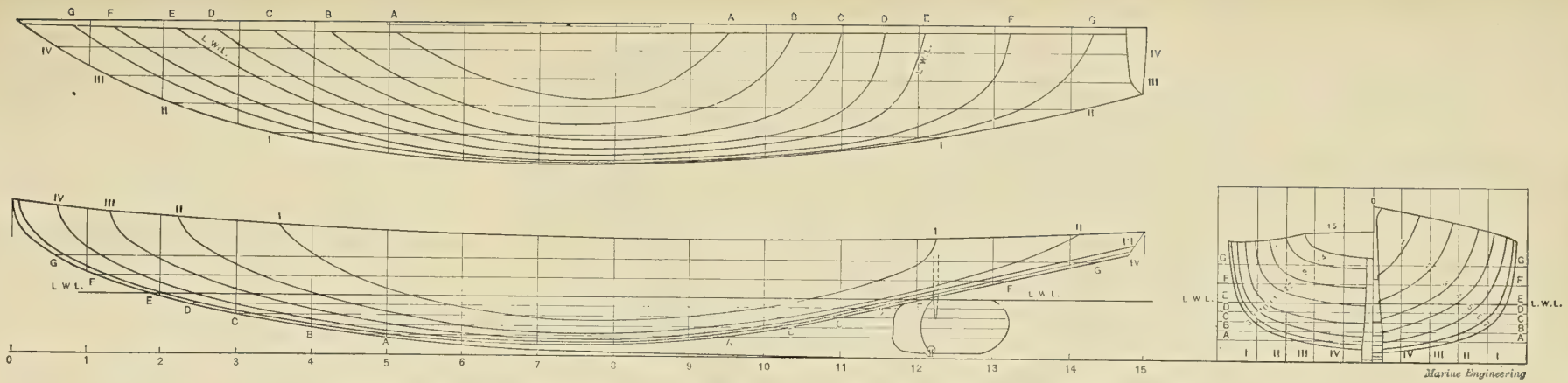
Sixty-Foot Auxiliary Yawl.

There was just completed at the works of the Electric Launch Company, Bayonne, N. J., a 60-foot auxiliary yawl named the *Naulahka,* and designed by the builders for Mr. R. Waverly Smith, of Galveston, Texas. The dimensions of this yawl are as follows:

Length over all	60	ft.
Length of load-water line	40	"
Beam	15	"
Draft without centerboard	3	"

The boat is designed for use in Galveston harbor and the construction is heavy throughout. The keel is of white oak, thoroughly through bolted. The frames are of oak, spaced 12-inch centers, held by heavy bilge clamps and floors. The deck is of white pine laid in narrow strips, calked, payed, and puttied. The planking is of yellow pine.

There is a large steering cockpit aft, with a level floor for accommodating chairs, as will be seen from the plan. The cabin is large, well ventilated, and has two skylights and twelve port lights, the transom seats form-



WATER LINES AND BODY PLAN OF SIXTY-FOOT YAWL DESIGNED AND BUILT BY THE ELECTRIC LAUNCH COMPANY.

ing berths 30 inches wide for accommodating four guests. The entire finish of the cabin is quartered oak, highly polished and finished with spar varnish.

The owner's state room is a large room with a double berth, folding washstand, bureau, mirror, etc., and adjoining it is a bath room furnished with a 60-inch tub and open type of yacht water closet. The galley is commodious and is equipped with an ice box, sink, and stove. In the forecastle are accommodations for a crew of two.

The yawl is equipped with a 14-horse-power, four-cylinder gasoline engine, with which a speed of 7 to 7 1-2 miles an hour can be obtained in smooth water. A gasoline tank with a capacity of 100 gallons is placed under the deck aft, there being a double bottom in this compartment draining overboard. This safeguard is taken to prevent the gasoline from running into the bilge if the tank should leak. A complete electric light and storage battery plant is installed, there being ten lights distributed throughout the cabin and also four electric fans to assist in ventilation. The power for running the dynamo is taken from the main engine, while the electric circuit may be connected to the storage battery when the engine is not running.

The *Naulahka* is handsomely finished, both outside and inside, and is completely equipped with furnishings, deck awnings, etc. On April 15 this staunch vessel sailed for Galveston, Texas, under her own power.

Gun Positions of the Battleship Maine.

An official report has been made by Capt. Eugene H. Leutze, of the new battleship *Maine,* about the condition of his vessel as a result of the "shaking down" cruise in the West Indies. Much has been said about the *Maine* in the daily newspapers to the effect that she was structurally weak, whereas Capt. Leutze's statement showed that the battleship has only developed weakness in the supports and placements of her 6-inch guns and in the foundations of her turrets. The cause of the giving way of the supports and rivets is due entirely to the increased muzzle energy of her guns, resulting from the use of smokeless powder. The turrets were designed in accordance with designs of previous battleships, which used ordinary brown powder.

Rear Admiral Bowles, the chief naval constructor, has issued a statement of the vessel's condition as follows:

The officers who have examined the turrets of the *Maine* have found that the damage done consists largely of the loosening up and breaking of fastenings and rivets in the circular structure underneath the rollers and paths on which the turret is supported, and in no respect due to general structural weakness of the ship. The supports under the roller paths are of the usual construction, being built up of plates and angles.

Since the date of the design of the *Maine,* however, the use of smokeless powder with higher pressure guns has been adopted and the recoils allowed have been shortened. Both of these improvements, while desirable of themselves, have greatly increased the strain on the supporting structure, which in actual test of firing has proven inadequate.

Were it not for the great weight of the revolving part of the turret, amounting to over four hundred tons, the fitting of the additional stiffening in the supports which has been decided to be necessary would not be a very elaborate work; but, owing to the great superincumbent weight which must be supported and the inaccessibility of the parts, it is anticipated that the repairs will take some little time.

The deformations of the decks in the vicinity of certain 6-inch guns, due to the same general cause, are much less important and can be easily remedied.

The chief constructor considers that no blame can be attached to the contractors for the *Maine,* as there was no evidence whatever of defective workmanship.

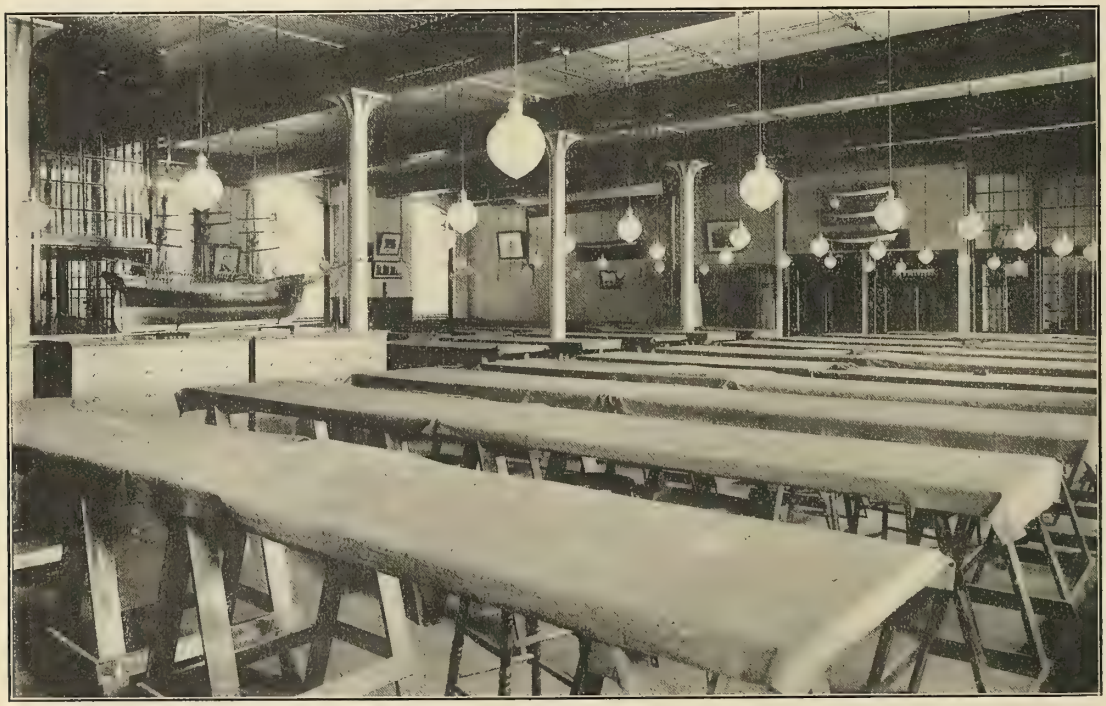
OUR SCHOOL FOR NAVAL CONSTRUCTORS.

When the chief European schools of naval architecture decided, a few years ago, to admit no more of the naval cadets of the United States who had borne off so many of their prizes, it was a fortunate stroke for naval science in America. Our government, thrown back on its own resources, looked the country over and determined that if its young naval constructors must be educated at home they should be educated here as thoroughly and broadly as was possible in the old and famous schools abroad. To undertake this large work the Navy Department chose the Massachusetts Institute of Technology in Boston.

This experiment—for such it was in its inception—began almost two years ago. The second group of naval cadets—or midshipmen, as they are now known—is completing its first year at the Massachusetts Institute, and five more midshipmen of high scholarly promise now enter the school to take such part of the year's work as is possible, and to make up the rest in the summer, so as to join the class which entered last autumn. The urgent demand upon the construction corps for the great number of new ships now building makes this addition imperative.

The young Annapolis men who take this course of elaborate instruction at Boston are selected from the classes that have finished a four-year course at Annapolis and passed one year at sea. They enter the junior year of the four-year course in naval architecture at the Massachusetts Institute of Technology, and take there the junior and senior years and one graduate year, which gives them the theoretical work of the whole regular four-year course in Boston and one additional year of theory. This advanced year has not yet been entered upon by the navy students, nor have its details yet been completely arranged.

Though this school of naval architecture is not an old one, it is firmly established and possesses an excellent equipment. It now has, all told, eighty or eighty-five students in its sophomore, junior, and senior years—an excellent representation out of the 1,600 students in the Institute. The growth of this school has, in fact, been rapid beyond anticipation. It has felt the influence of the swift advance in American shipbuilding and the increasing interest in the navy and maritime affairs throughout the nation. There are three Annapolis men in the senior and four in the junior class. These young men all come under the supervision of Prof. Cecil H. Peabody, who has long had charge of the department of naval architecture and marine engineering. The subject of warship design is especially in the hands of Prof. William Hovgaard, captain in the Danish navy, who was formerly connected with the Royal Naval College at Greenwich. Besides these two officers of the department there are Mr. Walter S. Leland, instructor in naval architecture; Mr. Allen L. Appleton, assistant in naval architecture; and Mr. Charles F. Willard, assistant in marine engineering.

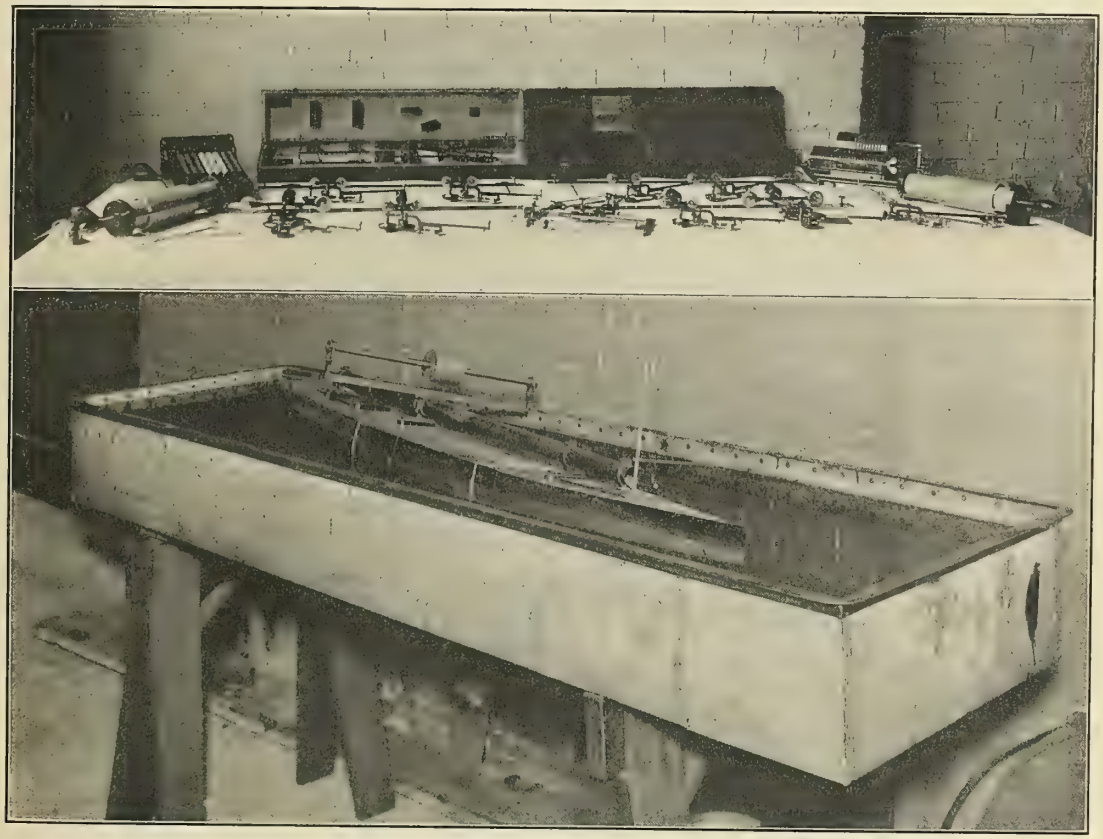


MAIN DRAWING ROOM, NAVAL CONSTRUCTION DIVISION, MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

The work of warship design naturally fills more time than anything else with the Annapolis students. But they receive also instruction in steam engineering, marine engineering, applied mechanics, and electricity in the many and important forms in which it is now utilized in warships. There are also courses on sanitation, heating and ventilating, foundations, metallurgy and metallography. There are lectures, laboratory work on paints, oils, and other organic materials of ship construction, and from time to time the young men listen

to addresses by naval constructors and other specialists on various themes of importance in naval architecture. The three-year course of the naval cadets, with its third year corresponding to the graduate work in other departments, leads up to the degree of Master of Science.

The general course of instruction is a broad one; it assumes that the result shall be a well-grounded scholar and gentleman. The midshipmen who are candidates for the construction corps of the United States navy come to Boston with an excellent foundation in the four-year course of study at Annapolis, supplemented by a year afloat on some cruising warship. The sea is of the Fore River Ship and Engine Company, where much government work is now under way. Besides, Boston and the towns around are a perfect hive of industries of all kinds. Machine shops especially abound, and at South and East Boston there are several minor but excellent shipbuilding and repairing establishments. Moreover, the atmosphere of the neighborhood is distinctly maritime, and Boston merchants and shipowners are making a brave fight to regain their old prestige on the deep ocean. The port of Boston is crowded with deep-sea ships and coasters of widely varying types and tonnage, and there are, therefore, many opportunities



INTEGRATORS, CALCULATING MACHINES, AND FLOATING MODEL OF SHIP IN TANK.

not now a mystery to them, they have met and faced it, they know something of its bewildering caprices, its force, and its majesty; they are, in fact, already young sailors and are the better fitted by their short experience at sea to grapple with the problems involved in the complex art of modern naval architecture. Taking all together the summer practice cruises of the Annapolis course and the sea year that follows, these students have had a good opportunity to observe the actual behavior of ships in varying conditions of wind and weather. Here is good, solid, practical instruction for a beginning. In the school at Boston the aim is to work out that fine blending of the practical and theoretical which is requisite to enable the United States naval constructors to meet the constantly enlarging demands of an arduous profession.

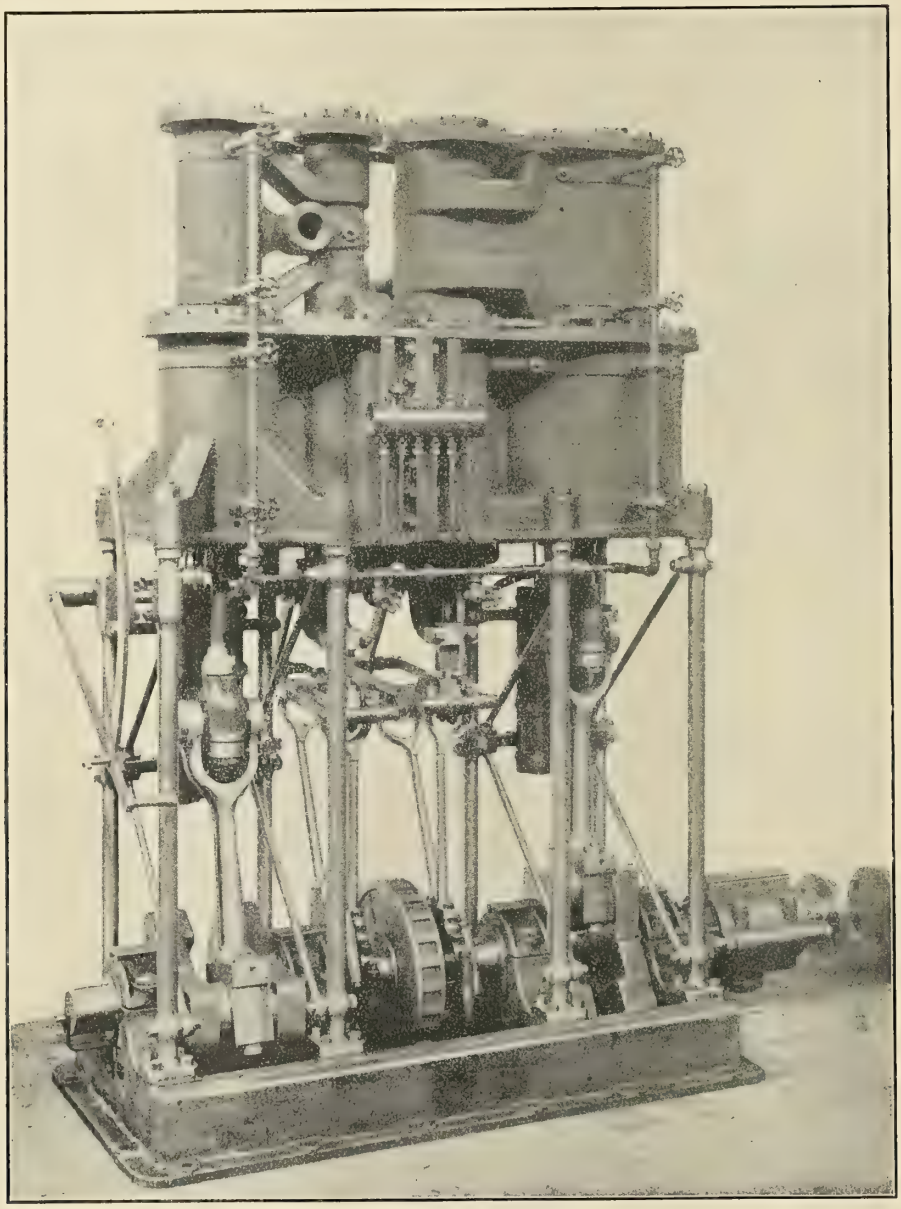
Boston is an admirable location for a school of this kind; the Charlestown Navy Yard, its docks and its great workshops, are near at hand, and Boston harbor also holds at Quincy Point the fine new steel shipyard for witnessing progressive speed trials, tests of engines and boilers.

The department of naval architecture possesses an excellent library of standard works on naval architecture and marine engineering, and its students have free access to the greater libraries of engineering, physics, and chemistry and to the many and well-equipped laboratories of the Institute. Here the men are made acquainted with the laying out and fairing of the lines of the ship; and in carrying out the design, structure and arrangement are carefully studied. They are instructed in the ways of making the necessary calculations of displacement, metacentric height, longitudinal and transverse metacenter, stability, efficiency, etc. They are also instructed in the best processes of launching and of docking.

The work in marine engineering familiarizes the student not only with the history of marine machinery and the general theory of steam propulsion, but with the

actual planning and working of modern engines of the best and most effective type. It is expected that the student, in connection with his theoretical work, will make exact drawings and calculations for the preliminary design of marine engines, thus applying thoroughly the principles which he has learned.

With the increase in the construction corps which must follow the steady increase of the United States navy, it will probably become necessary to send more and more of the Annapolis men to Boston for this elaborate course of instruction. The Massachusetts Institute of Technology is throughout a school of keen conscientiousness and broad ambitions, and these characteristics especially belong to the department of naval architecture. It is realized that the new task which the navy has set the Institute is an honor as well as a responsibility; that it enhances the fame of the Institute and that it makes it still more distinctly national. The direction of the work of the young naval constructors in Boston rests in strong, competent hands.

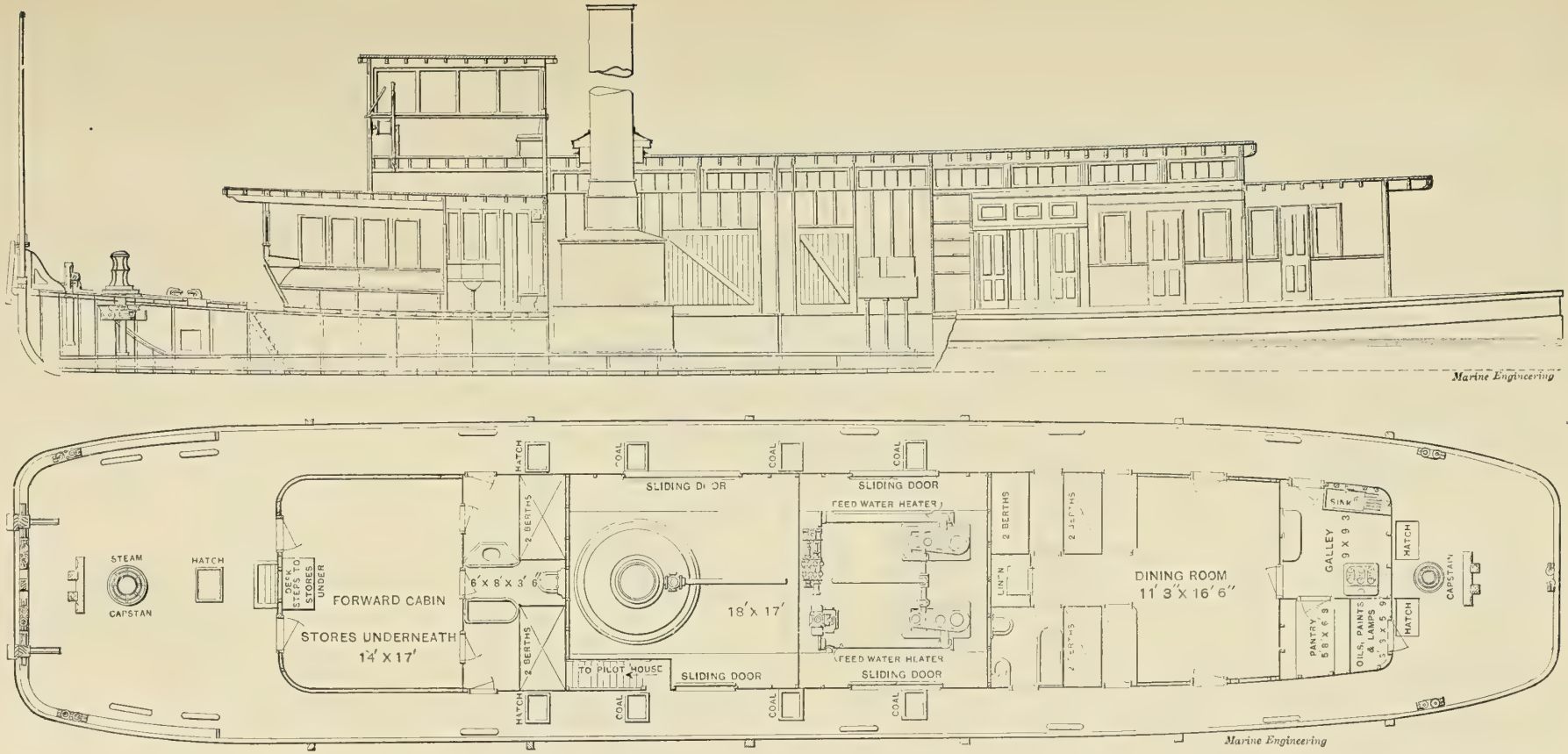


QUADRUPLE-EXPANSION, TWO-CRANK ENGINE OF THE OHIO AND KANAWHA RIVER TOWBOAT JAMES RUMSEY.

STEAM TOWBOAT RUMSEY.

Further particulars concerning the *James Rumsey*, which underwent such a unique test and was described in Marine Engineering for April, are forwarded by the designers and builders, Ward's Engineering Works, Charleston, West Virginia.

The vessel was built for the United States Army Engineer Corps for towing barges, dredges, etc., used in the improvements of the Ohio and Kanawha rivers. She is



ELEVATION AND DECK PLANS OF THE TWIN-SCREW TOWBOAT JAMES RUMSEY, BUILT AT WARD'S ENGINEERING WORKS.

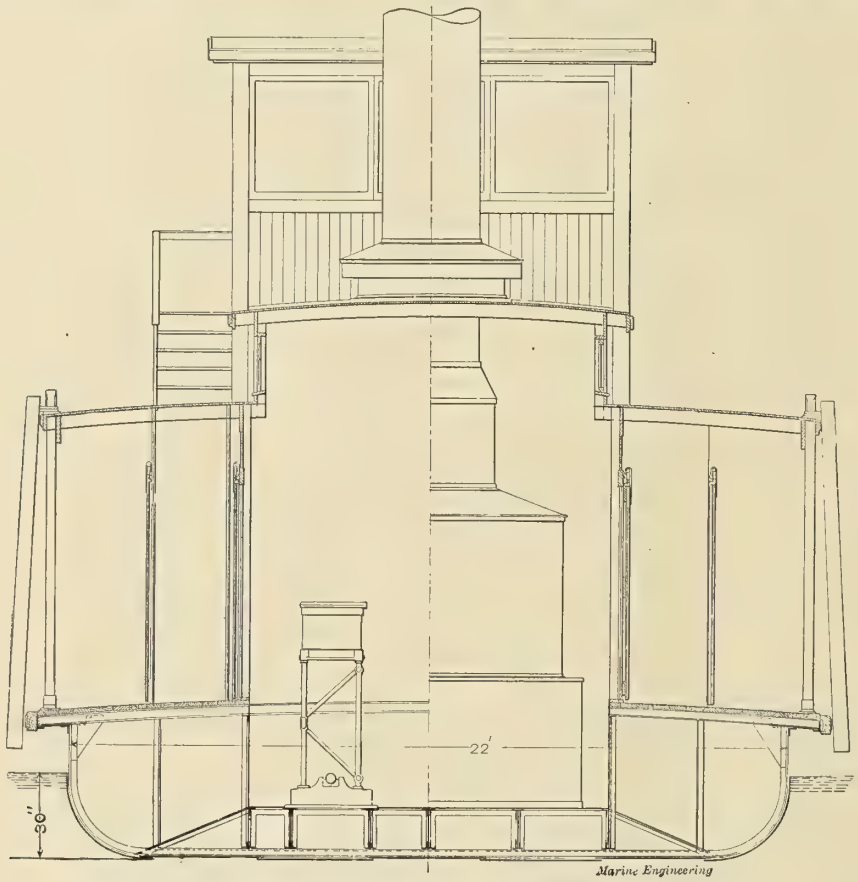
120 feet long, 22 feet beam, 4 feet 6 inches deep, and her displacement, light, is 100 tons, with a draft of 32 inches aft and 24 inches forward. The hull is built of steel throughout and is divided by four thwartship bulkheads, making five water-tight compartments. There are also two longitudinal bulkheads extending the full length of the boat.

The machinery occupies the middle compartment, which is 33 feet long, and on either side are coal bunkers with a capacity of 40 tons, which will carry the vessel 1,000 miles at a speed of ten miles. The machinery consists of a pair of two-crank quadruple-expansion engines, 7, 10, 14, and 20 inches by 12 inches stroke. The cylinders are mounted in pairs and upon a steel frame; the valves of the four cylinders are of the piston type, operated by Stephenson link motion; the crosshead and the slipper guide are of steel. It is seen from the engraving that this makes a very compact, strong arrangement. The high-pressure is above the first intermediate cylinder and the second intermediate is placed on the low-pressure. The cranks are 90 degrees apart and are counterbalanced. The contract requirement for the *James Rumsey* was that the engines were to develop 425 I.H.P., but the indicators have shown a maximum of 550 I.H.P.

The boiler is the regular Ward sectional-coil type and has 50 square feet of grate surface and 1,650 square feet of heating surface. The safety valve is set at 220 pounds,

although the working pressure allowable is 250 pounds. There is a simple vertical light-weight air pump and a duplex outside-packed plunger feed pump. An outside sectional condenser is mounted on either side of the boat, one for each engine.

There are two four-bladed propellers, 4 feet 3 inches diameter, placed in tunnels near the stern, so that the tips of the blades are slightly above the bottom of the boat; thus, at rest the tops of the blades are 21 inches above the water line. Manholes placed over the propellers admit of their being changed or removed without docking the boat. When under way this tunnel is filled with water by the suction given by the screw, and thus the blades revolve in solid water.



MIDSHIP SECTION OF THE JAMES RUMSEY.

A special form of propeller is used, which is designed to give good backing power, as a large part of the work of this boat will be in backing, as well as towing and pushing. This is necessary in order to handle the large floats of coal which are taken down the river in barges, when going around bends or over the shoals; the tugboat then reverses her engines, holding back, while the current swings the tow in proper direction.

The contest described in the last issue with the *D. T. Lane* was most conclusive, as the latter vessel was recognized to be the best towboat of the old class on the river. By means of scales the *Rumsey* backs 75 per cent. as much as she pushes, while it was calculated that the stern-wheel vessel backs from 50 to 60 per cent. as much as she pushes.

The New English-Built Chilian Battleship Libertad.

The battleship *Libertad,* for the Republic of Chili, was recently launched by Her Excellency Madame de Gana, from the Naval Construction Works at Barrow-in-Furness of Vickers, Sons and Maxim, Ltd., shown in the accompanying illustration. The builders made a record for themselves in the length of time required from the laying of the keel to the launch. The keel was laid on April 7, 1902, and the ship was launched on January 15, 1903. The Chilian government placed the order for this ship complete in every particular, including armament, engines, and equipment. This, no doubt, is one of the reasons for the quick work. This custom is so different from that employed by our own department and the British Admiralty, wherein the contract is subdivided between different firms.

It is probable that the *Libertad* is one of the most powerful battleships of her size building, only a few of the more costly ships, of greater displacement, surpassing her. Her principal dimensions are as follows:

Length between perps	436 ft.
Breadth	71 "
Draft	24 " 7 1-2 ins.
Displacement	11,800 tons.
I. H. P.	12,500
Speed	19 knots
Armor plate	7 inches to 6 inches
Armor, gun positions	10 inches to 7 inches

The main battery consists of four 10-inch and fourteen

7-5-inch rapid-fire guns, and the secondary battery comprises fourteen 14-pounders, two 12-pounders, four 6-pounders, four 1-pounders, and four Maxim machine guns. These splendid fighting qualities have been provided, as will be noted, upon limited dimensions, and the high speed has been obtained without the sacrifice of armor or radius of action, as the ship carries fuel and supplies to enable her to steam 11,000 sea miles at 10 knots.

The following information is taken from *London Engineering:* The weight of projectiles from the whole of the ship's armament in one single round equals 5,846 pounds, or 427 pounds for each 1,000 tons displacement of the ship, while including only the primary guns the weight equals 407 pounds per 1,000 tons; and this can be said only of the new battleships of any other power. The round from primary guns in the latest French ships is 306 pounds, and of Russian and German ships 290 pounds per 1,000 tons.

The mechanism of the Vickers guns, too, gives a great rapidity of fire and high power from each round. Thus, in a minute the Chilian ship may fire from her primary guns 12 projectiles of 500 pounds = 6,000 pounds and 335,568 foot tons in energy; 98 projectiles of 200 pounds = 19,600 pounds and 1,186,584 foot tons in energy; total, 110 projectiles = 25,600 pounds and 1,522,152 foot tons of energy. From each broadside there can be fired per minute 12 projectiles of 500 pounds and 49 of 200 pounds, a total of 15,800 pounds, with an aggregate energy of about 928,800 foot tons. Each 500-pound capped shot could perforate, at half a mile range, the broadside armor of any ship afloat; while the 200-pound shot could perforate 6-inch armor at 1,000 yards range.

When chasing the enemy the ship can fire ahead each minute 6 projectiles of 500 pounds and 56 of 200 pounds, in all 14,200 pounds, with a collective energy of about 845,900 foot tons.

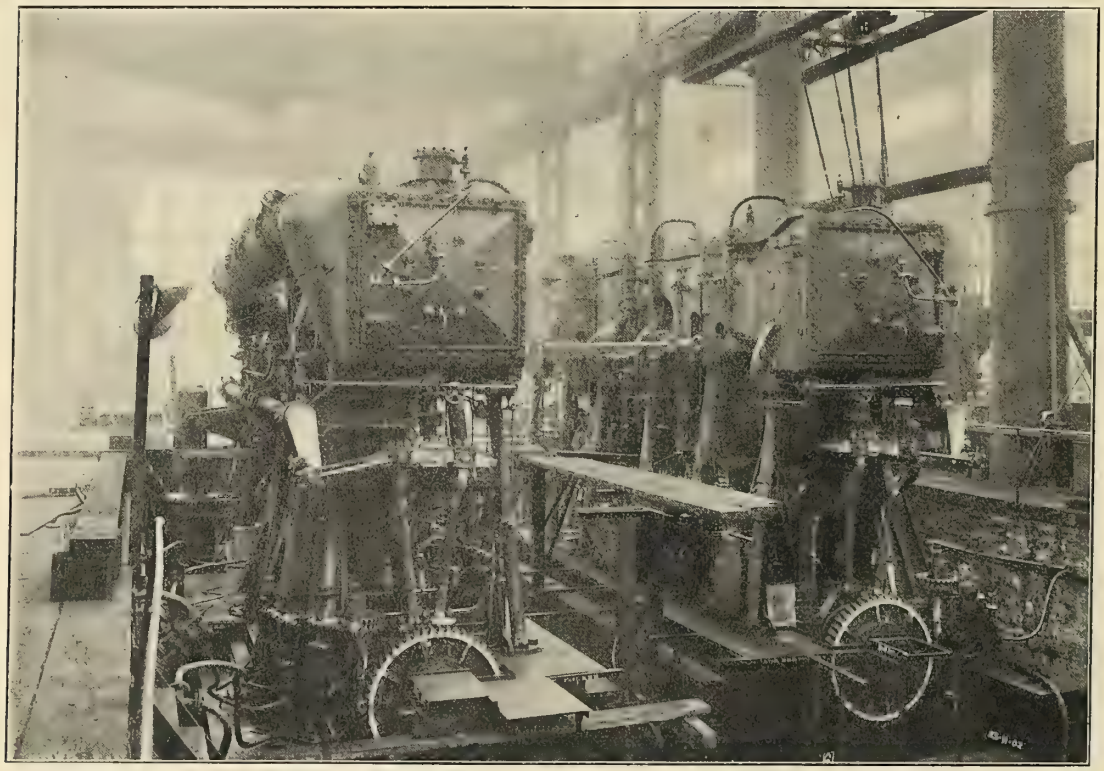
This ship has also an immense gun power against torpedo or submarine boat attack. Her smaller guns fire per minute 280 projectiles of 14 pounds, 112 of 6 pounds, 1,200 of 1 pound (pompoms), and 2,000 rifle bullets, so that the enemy, once discovered, would have little chance of escape.

LAUNCH OF THE CHILIAN BATTLESHIP LIBERTAD, AT THE WORKS OF VICKERS, SONS AND MAXIM, LTD.

The defensive qualities of the ship are equally satisfactory. Armor manufactured at the Sheffield works of the company, according to the latest process, forms a citadel in the center of the ship, and within this are ten of the 7.5-inch guns. In addition to the 7-inch armor forming the citadel walls, there are armored partitions separating the guns, so as to localize the damage from such shot as may find its way into the ship. The main armor extends for the full length of the ship on the water line, being reduced to 3 inches near the ends. Four of the 7.5-inch guns are in casemates of 7-inch armor on the upper deck, and the 10-inch guns are in 10-inch armored barbettes at the forward and aft ends

of the ship. The smaller guns, while sheltered, are in positions to command the enemy from all points. In action the ship and all the guns may be controlled from a conning tower built of 11-inch armor.

When completed, this vessel and her sister ship, both constructed under the direction of Sir Edward Reed and Admiral Simpson, will certainly constitute the finest fighting machines in South American waters, and will carry all the latest scientific inventions for signaling and other purposes, as supplied to the latest ships of European navies. She is a sister ship to the *Constitucion,* which was launched a short time ago for the Chilian government by Armstrong, Whitworth and Company from the Elswick shipyard at Newcastle.



TRIPLE-EXPANSION ENGINES FOR THE CHILIAN BATTLESHIP LIBERTAD.

It is stated that from the heavy battery on the battleship, with all of the guns firing at their maximum speed, a total of thirteen and a half tons of metal will be delivered in one minute, with a combined energy of nearly two million foot tons.

A few particulars of the launch of this ship are as follows: The standing ways were 550 feet long and of such width that the total launching weight of 6,700 tons, including cradle, was reduced to 1.64 tons per square foot. The inclination of the standing ways was 12-32 inch per foot. Forty-eight seconds elapsed from the first movement until the vessel was afloat, and from that point the ship traveled 195 feet, when she was brought to a stop, although there was plenty of width and depth of the waterway to allow for a long run. The vessel was pulled up by drag chains weighing in all 400 tons. As will be seen from the engraving, there are four chains on each side and these came into operation at successive stages in the ship's downward course. An additional stern drag anchor was firmly bedded in shore and connected to the ship's quarter by a 7-inch flexible steel wire rope, which came into play at the end and brought the vessel to a standstill. The anchor was found to have dragged a distance.

Large Anchors.—The anchors to be used on the warships *Tennessee, Washington, Connecticut,* and *Louisiana* have been ordered to be made at the Charlestown Navy Yard, Boston, Mass. Each of the ships will be given four of these anchors, weighing 17,600 pounds each, and four stud-link chains of 3 3-16-inch metal. This work is under the charge of the Equipment Department, which is also turning out anchors and chains for other battleships. In fact it is stated that every chain for the United States warships comes from the Charlestown Navy Yard.

Nine Months' Shipbuilding Returns.—The Bureau of Navigation reports 418 sail and steam vessels of 230,187 gross tons built in the United States and officially numbered during nine months ended March 31, 1903. The wooden tonnage, half of which was built on the Atlantic and Gulf, amounted to 22,324 gross tons, while of the steel tonnage 67,767 gross tons were built on the Atlantic and Gulf and 60,646 gross tons upon the Great Lakes. During the corresponding nine months a year ago there were 949 sail and steam vessels of 245,068 gross tons built in this country and officially numbered, showing a falling off of 4,108 tons of wooden construction and 14,881 tons of steel.

A COMPARISON OF THE TRIALS OF THE NEW MONITORS OF THE UNITED STATES NAVY.

Of the four monitors authorized by Congress a few years ago, all have now run their acceptance trials, and the results form such a valuable contribution to the vexed subject of propeller design that we have compiled the following summary from the detailed reports given in the last two numbers of the *Journal of the American Society of Naval Engineers,* and through the courtesy of Rear Admiral Geo. W. Melville.

The general dimensions of these vessels, which are all alike, will be found at the bottom of this column.

sions of the propellers, as recommended by the Bureau of Steam Engineering, are given in Table I.

The areas are for one wheel only. The screws of the four monitors were true pitch.

The *Nevada* was tried off Cape Ann, one run each way, over a course of 13.2 nautical miles. The *Arkansas* ran standardization trials on the Barren Island course, and her two-hours acceptance trial took place off Cape Henry, in free route, in the open sea. The *Wyoming* standardized her screws in San Francisco bay and made her two-hours speed trial in "the open sea." The *Florida* was run over a measured course in Long Island sound and at one speed only.

TABLE I.

PROPELLER DATA OF MONITORS.

	Screw Proposed, Bureau Steam Engineering.	*Wyoming.*	*Arkansas.*	*Nevada.*	*Florida.*
Diameter, feet	9.0	8.0	9.0	9.23	8.5
Pitch, feet	8.28	8.49	7.25	7.80	8.32
Pitch ratio	.92	1.06	.85	.85	.90
Developed area, sq. ft.	28	25.8	25.6	24.0	26.0
Projected area, sq. ft.	24	21.2	22.6	21.0	22.0
Disc area, sq. ft.	63.6	50.3	63.6	66.6	58.1
$\frac{\text{Developed area}}{\text{Disc area}}$, per cent.	.....	51.3	40.2	36 0	44.7
Diameter of hub, inches.	.....	26.8	24.8	24	.....

TABLE II.

TWO-HOURS ACCEPTANCE TRIALS.

	Arkansas.	*Wyoming.*	*Nevada.*	*Florida.*
Revolutions, starboard	197.9	201.3	186.46	199.61
" port.	196.3		188.19	
I. H. P. main engines.	1717.38	2325.71	1942.37	2317
Speed, knots	12.713	11.8	13.039	12.4
Slip, starboard	9.91	29.72	9.16	24.45
" port.	8.97	30.42	9.99	
Steam at boilers.	204	227	239	.....
" " engines.	146	216	189	.....

Length of load-water line..... 252 feet
Beam at water line..... 50 "
Draft to water line, normal..... 12.5 "
Corresponding displacement ..... 3,218 tons
Block coefficient ..... .715
Area of immersed midship section.. 597 sq. ft.

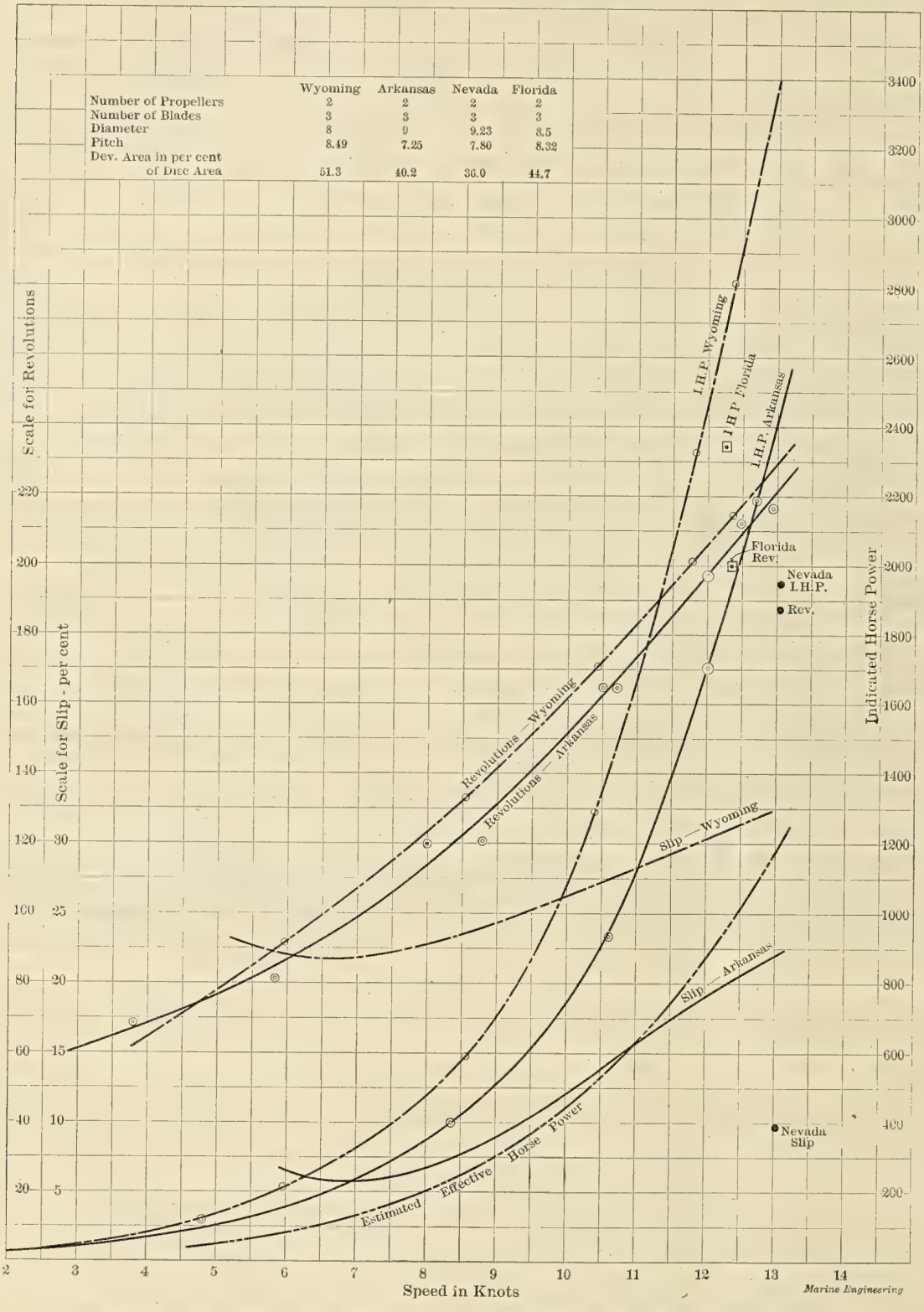
The *Wyoming* was run at the above draft and displacement, the *Arkansas* at 12.6 feet draft and 3,233 tons displacement, but the figures for the *Nevada* and *Florida* are not given. It is, however, unlikely that any but a small variation would be tolerated in a naval vessel of this class, and for practical purposes we may consider the hulls and therefore the resistances of these vessels as identical.

The dimensions of the engines are 17, 26 1-4, and 40 inches by 24 inches stroke. Each vessel had two of these engines, driving three-bladed twin screws. The dimen-

ARKANSAS—STANDARDIZATION TRIALS.

Number of Run.	Direction.	Revolutions per Minute.	Speed in Knots.	I. H. P. Both Main Engines for Each Round Run.
1	S	81.61	5.831	119.11
2	N	68.69	3.786	
3	S	121	8.803	403 09
4	N	120.35	7 997	
5	S	165.30	10.490	932.35
6	N	165 56	10.692	
7	S	212.26	12.470	2189.86
8	N	216.74	12.955	

It will be noted from the preceding Tables I. and II. that, with the two propellers having about the same diameter as that proposed by the Bureau of Steam Engineering, the efficiency increases as the pitch rises toward that given for the proposed propeller, while with the two smaller propellers the efficiency increases as the diameter is increased and as the pitch decreases toward that of the Bureau's propeller. All propellers are slightly under the area that the Bureau considered necessary. It is well to note here that as the contractors alone are



CURVES OF HORSE POWER, REVOLUTION, AND SLIP FOR OFFICIAL TRIALS OF THE UNITED STATES MONITORS.

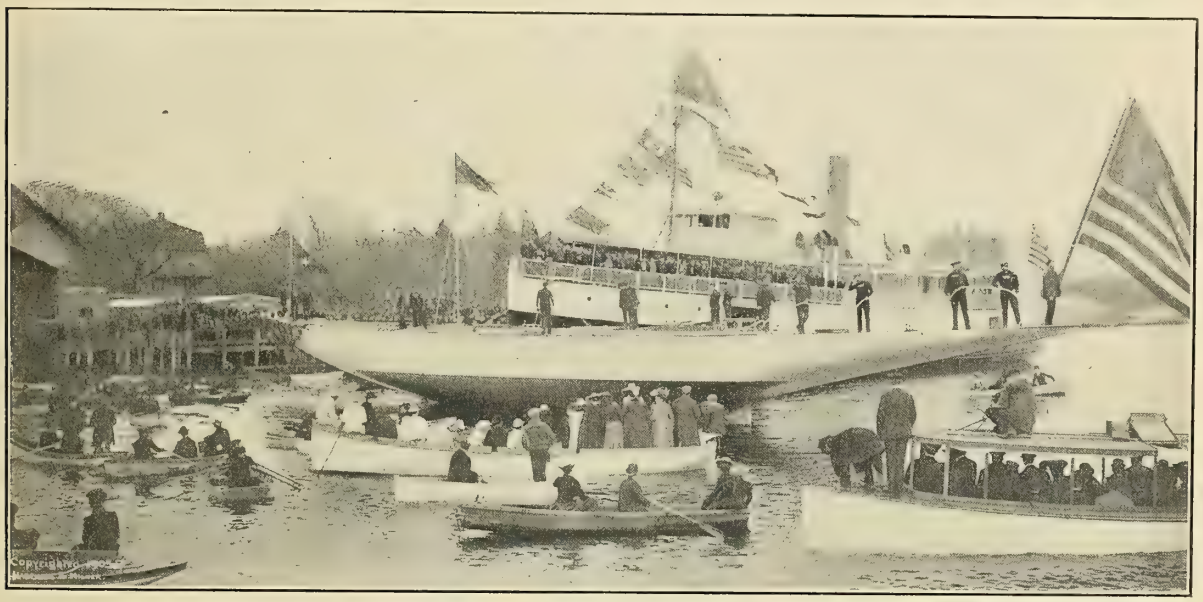
responsible for obtaining the contract speed of the vessels upon trial, the propellers are designed by the contractors. However, when a plan is submitted to the Bureau which is not radically wrong, it is allowed, and, at the same time, the contractor is advised what the Bureau considers to be preferable dimensions for the propellers. Should the

WYOMING—STANDARDIZATION TRIALS.

Double Run.	Rev. per Min.	I. H. P.	Mean Speed in Knots.
1	91.5	211.55	5.97
2	134.2	589.99	8.57
3	170.5	1295.50	10.40
4	214.7	2811 01	12.37

official trial took place on Long Island sound, off Stratford Shoal light, over a course of twelve nautical miles, marked by stakeboats and buoys at the ends and in the middle. The trial run consisted of a preliminary run in one direction over the course, not timed, and was followed by the official run over the course and return. It is stated by the builders that, owing to very thick weather on the official run, the last lap was steered almost entirely by compass, and on all of the runs half the distance, six miles, from buoy to buoy, was passed before the pilot was able to pick up the next buoy. As the vessel is fitted with a liquid compass, which was at the time more or less imperfectly compensated, the steering of the monitor was not satisfactory, and it is probable that the vessel lost considerable speed through yawing.

There was possibly a slight error in the speed of the



LAUNCHING THE NEW CUP DEFENDER RELIANCE, AT BRISTOL, R. I.

[Photograph copyright, 1903, by Hastings and Miller.]

Navy Department insist on furnishing the propeller designs, in the event of a ship's not attaining contract speed the contractor would be relieved of responsibility.

From these tables are drawn the curves of the accompanying diagram for the *Wyoming* and *Arkansas,* the lack of data preventing drawing curves for the other two monitors. There is also added to the figure a curve of assumed effective horse power, drawn according to Taylor's formula, which is of course only an approximation, but helps to give an idea of the magnitude of the power losses. It is roughly confirmed at 13 knots, as it gives a propulsive efficiency of 61 per cent. for the *Nevada,* and judging by the other boats her performance was extremely good. The contract speed of 11.5 knots was obtained with 2,060 I.H.P. on the *Wyoming,* 1,400 with the *Arkansas,* and how much more or less in the other cases we do not know. The *Nevada* attained a speed of 13 knots upon 1,942 I.H.P., and in the other vessels this speed would have apparently been obtained with 3,390, 2,420, 2,800 I.H.P., respectively.

The *Florida* did not run standardization trials, and the *Nevada* by which her apparent speed may have been increased, as the buoys marking the course of the trials were laid down several days prior to the trials, and bad weather existed between the time the buoys were placed and the date of the trials. There is no doubt, however, that the greater part of the differences in the speed performances of these vessels was due to the propellers alone. The large amount of slip occurring with the smaller wheels was especially harmful under existing conditions of fine pitch ratio and a very full vessel. The horse powers varied directly as the diameters.

According to Froude's experiments such a vessel might be expected to have a wake factor of fifteen to twenty per cent.; that is to say, that the water in which the propellers work has had imparted to it by the friction of the hull an average speed of one-fifth the speed of the vessel. Froude found that, with ordinary values of slip, the suction of the propellers was balanced by the gain in thrust due to this forward motion of the wake, but it certainly here appears that the high slips increased the resistance far above the gain due to the wake.

It would be interesting to know what was the depth

of water for the standardization and two-hour trials, as this may in part account for the superiority shown by the *Nevada.* It is to be hoped that this article will elicit communications from those who are acquainted with the details of the trials, of the propeller designs, or in fact any facts which might lead to this abnormal difference.

Reliance Overboard.

The new cup defender *Reliance* was launched slowly and without a hitch of any kind from the Herreshoffs' yard at Bristol, R. I., on April 11. The launch took place just before sunset, and as the 90-foot yacht slid into the water she was for the first time seen by the outside world. The speed of the launching cradle was regulated by blocks and fall, so that it took just eleven minutes from the time the yacht started, when she was christened by Miss Nora Iselin, to the time she was water borne. Two minutes elapsed after the vessel began to move down the ways before the first part of her hull touched the water. The onlookers had plenty of time to see the hull before it was immersed, and the general impression seems to be that the *Reliance* will be an exceptionally speedy boat. It is stated that the new yacht is a radical departure in design from the *Columbia* and *Constitution,* and in the proper directions. She has great beam, and the increased after overhang tapers off to a fine point. The bilges are higher and the floors flatter than in the previous defender. Although she is termed a scow, her lines are most graceful in every point, and experts say that the bow and stern will be a great advantage in smooth water and light breezes. There are seven strakes of tobin bronze plates from the rail to the fin. The general dimensions are said to be: "Length over all, 141 feet, on water line 89.92 feet; beam, 25 feet 9 inches; draft, 19 feet 9 inches; estimated sail area, 15,000 square feet; the mast is to have only one pair of spreaders." While the above figures may be approximate, they are not to be considered reliable.

Institute of Naval Architects.

In 1903 the session of the Institute of Naval Architects was held in the hall of the Society of Arts, London, on April 1 to 3. The following papers were read and discussed:

1. The Effect of Modern Accessories on the Size and Cost of Warships. By W. H. Whiting, assistant director of naval construction, member.
2. The Lines of Fast Cruisers. By Vice-Admiral C. C. P. FitzGerald, associate.
3. The Training of Engineers in the United States. By Professor W. E. Dalby, M.A., B.S., associate.
4. The Modification of the Mean Pitch Due to Twisting the Blades in Screw Propellers. By Professor Angelo Scribanti, member.
5. Gradual Collapses of Furnace Crowns: A Suggested Explanation. By H. M. Rounthwaite, member.
6. The Ljungstrom Condenser as Applied to Marine Purposes. By W. Cross, associate.
7. The Screw as a Means of Propulsion for Shallow-Draft Vessels. By A. F. Yarrow, Vice-President.
8. The Ballasting of Steamers for North Atlantic Voyages. By S. J. P. Thearle, member of council.
9. On Marine Installations for the Carriage of Refrigerated Cargoes. By R. Balfour, engineer surveyor of Lloyd's Register.
10. Fitting Out Wharf Crane Service in American Shipyards. By W. A. Fairburn, member.
11. On Corrosion in Metal Pipes on Board Ship. By A. W. Stewart.

The Plymouth-City of Taunton Collision.

A serious collision took place on Long Island sound near Fisher's Island on March 20 between the two Fall River Line steamers, the *Plymouth,* bound east, and the *City of Taunton,* bound west. A heavy fog existed at the time and those in the pilot house of the *Plymouth* did not hear the *City of Taunton's* whistles until almost upon her.

The *Plymouth* is a steel ship with a complete watertight double bottom, while the *City of Taunton* is a wooden vessel. The *Taunton* struck the *Plymouth* on the starboard side a little aft of the pilot house, cutting through the guard and deck, ploughing into the side plating. As the *Taunton* drew away her stem ripped through the forward cabins, as shown in the accompanying cut. The compartment of the *Plymouth* which was thus opened to the sea contained the quarters for the crew. Four of them and one passenger were drowned; another member of the crew was killed outright. The collision tore away the entire bow of the *Taunton* down to her forefoot. Fortunately the collision bulkhead was not damaged. The steamboat *Nashua* towed the *Taunton* stern first into New London, where the *Plymouth* had already proceeded under her own steam. The sworn statement of Captain Bibber, of the *Taunton,* is as follows:

"Westbound March 19, had thick fog from Rose Island. About ten minutes to 12 P. M. I heard the *Plymouth's* whistle one and a quarter knots on the port bow. We stopped and blew three whistles. The *Plymouth* sounded about one and a quarter points on the port bow. We started ahead under one bell and hauled into west one and a quarter north, and, as the *Plymouth* did not widen out, we hauled into west by north three-quarters north. When I found he was coming on at us, I ordered the engines stopped and backed full speed. Just at that time I saw his green light about two points on the port bow. At five minutes past 12 A.M., the 20th, we collided, carrying away all the bow."

Captain Davis, of the *Plymouth,* made this statement:

"Left New York March 19, at four minutes after 5 P.M. The wind was moderate from the south. Thick weather. All went well until Gull Light was passed. Second Pilot Hambly was at the window. I sat just back of the starboard window. I heard one blast of a steam whistle. At the same time the pilot rang the stop and back-at-full-speed bells.

"I saw the headlight of the steamer *Taunton* off our starboard bow close to us, and in an instant she struck us head on, cutting through our guard and into the hull, so that our forward section filled with water, drowning three colored men, employees of the boat, and one white watchman. The impact stove our saloon deck and four state rooms, injuring one passenger, who died soon after the collision. Some few were slightly injured. The damage to the hull of the *Plymouth* is estimated at $20,000."

United States Steamboat Inspectors Withey and Daboll, of New London, have reported to Supervising Inspector Robert S. Rodie as follows upon the facts they have learned as to the collision between the steamers *Plymouth* and *City of Taunton* last month:

The cause of the collision between steamer *Plymouth,* Elijah G. Davis, master, and *City of Taunton,* John S. Bibber, master,

which occurred on the waters of the Race, on the morning of March 20, 1903, has been investigated by this local board and we hereby submit the following statement of our findings in the premises, to wit:

The evidence adduced in this case is deemed sufficient to show that these steamers were in charge of officers eminently fitted by long experience to perform their duties in an able manner. Dense fog prevailed; objects at a short distance were completely hidden; an atmospheric phenomenon known to, and frequently encountered by, master mariners, but as yet not explained by physical science, existed, viz.:

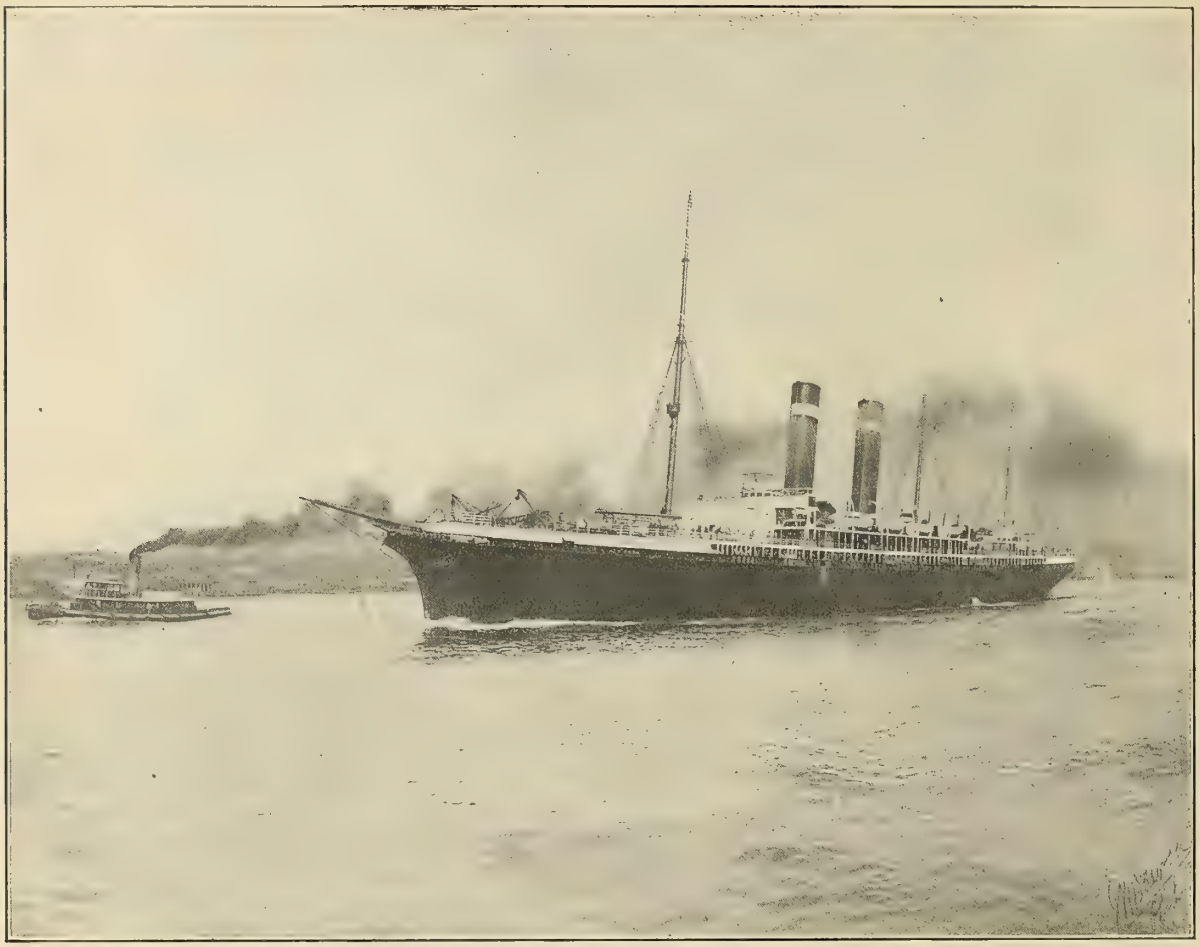
First. Where sounds given in fog from one direction fail to penetrate the atmosphere at an opposite point.

Second. Where sounds given in fog are distinctly heard, yet cannot be accurately located.

Under such conditions steamers *Plymouth* and *City of Taunton* did, on said date, approach each other on opposite courses. *Plymouth's* whistle was heard by *City of Taunton's* master, but its true bearing was inaccurately located; at an estimated distance of 500 feet away, master of *Plymouth* heard the *City of Taunton's* whistle sounded once only, and at the same instant distinguished her lights; with engines backing full speed the two steamers collided. We find the masters of the steamers not guilty of misbehavior, negligence, or unskillfulness, and do hereby exonerate them from all responsibility.

W. E. Withey, Charles M. Daboll, Local Inspectors.

THE STEAMERS PLYMOUTH AND CITY OF TAUNTON AFTER COLLIDING IN LONG ISLAND SOUND.



THE RECONSTRUCTED AMERICAN LINE STEAMSHIP NEW YORK.

THE RECONSTRUCTED NEW YORK.

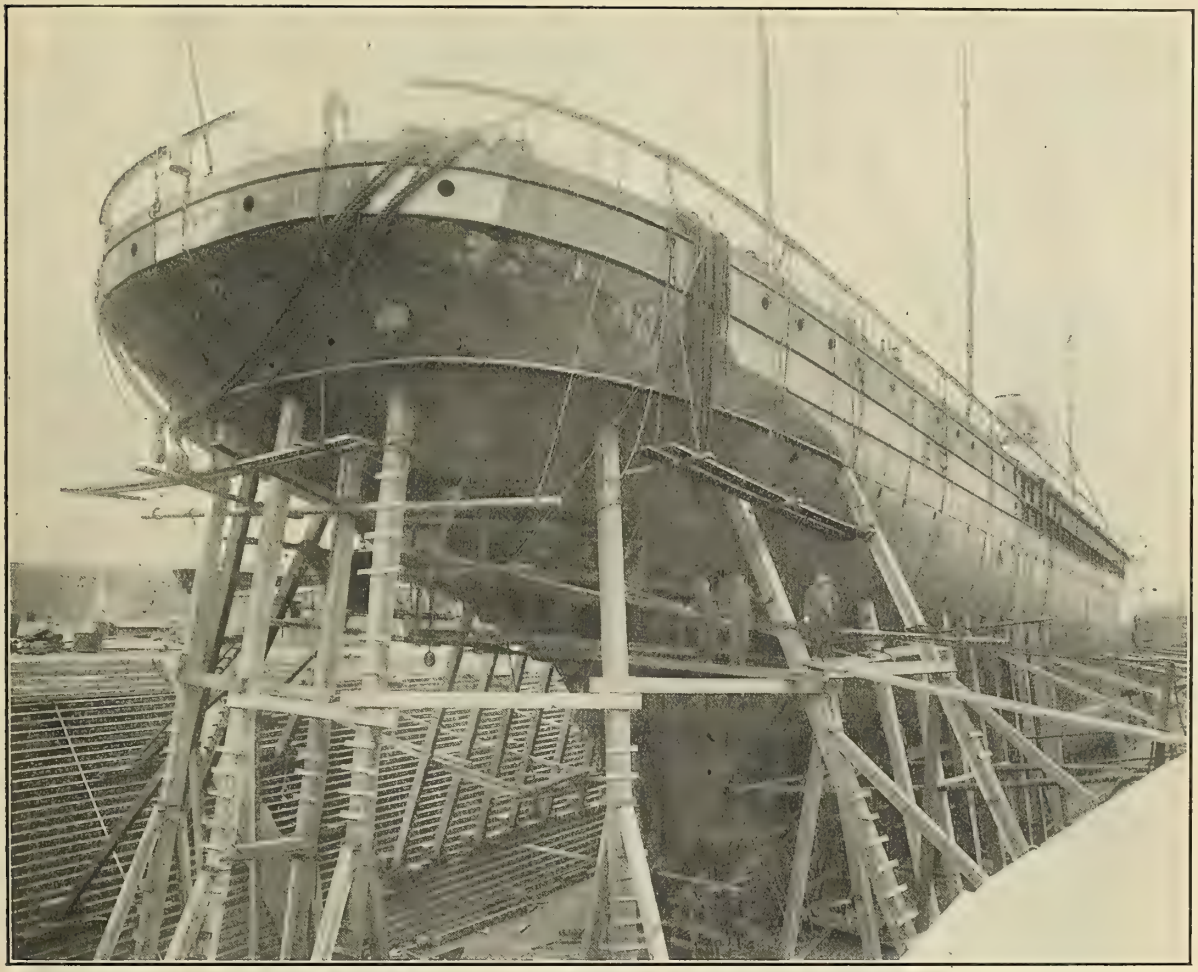
After nearly two years of absence from the Atlantic ferry the American liner *New York,* of the International Mercantile Marine Company, has now resumed her service on the United States mail line from New York to Southampton. It was on May 28, 1901, that the *New York* left her North River pier for the Cramp shipyard in Philadelphia to receive the thorough remodeling and renovation on which her owners had decided. Since the *New York* was first placed in commission, in 1888, she has won a fine reputation as a fast and comfortable passenger ship. The most brilliant page in her history, however, was her service as a merchant cruiser in the Spanish war, when, in the charge of Captain Charles S. Cotton, U. S. N., now Rear Admiral, with Captain F. M. Passow, who is again in the *New York,* as her commander, this steamer actually did more "scouting" and steamed over more miles of blue Atlantic than any of our cruisers regularly built for war.

In the spring of 1901 the International Navigation Company, now merged in the greater International Mercantile Marine Company, which owned the *New York,* decided to bring this favorite ship right up to the latest advances in marine engineering and naval architecture. The work was to be far-reaching and permanent.

At the Cramp shipyard the outfit of the vessel, including the passenger fittings, boats, and gear, was sent ashore. Then the workmen removed the funnels, uptakes, steam pipes, main boilers, main and auxiliary engines, dynamos, and ventilating and forced-draft fans, When this had been done and everything possible had been landed, the great ship was lightened so that she had a mean draft of only 16 feet of water. In this condition the *New York* was towed, on August 31, 1901, to the Erie Basin dry-dock in Brooklyn, for there was no dock large enough to receive her on the Delaware. The *New York* entered the dock at Brooklyn on September 25, 1901. There careful preparations had been made to receive her. The keel blocks were raised so as to give more than the usual height between the ship and the dock bottom and to enable the workmen to get easily at every underbody part of the vessel.

Now the task of removing the old propellers, propeller brackets, shafting, and rudder was begun, while the ship was made ready, by a complete system of bilge blocks and bilge and side shores, for the alteration of her stern and for the reconstruction necessary on account of the new boiler and engine arrangements.

It had been decided not only to give the *New York* complete new boilers and new engines of the latest



CUTTING AWAY THE STERN OF THE NEW YORK IN ERIE BASIN DRY-DOCK.

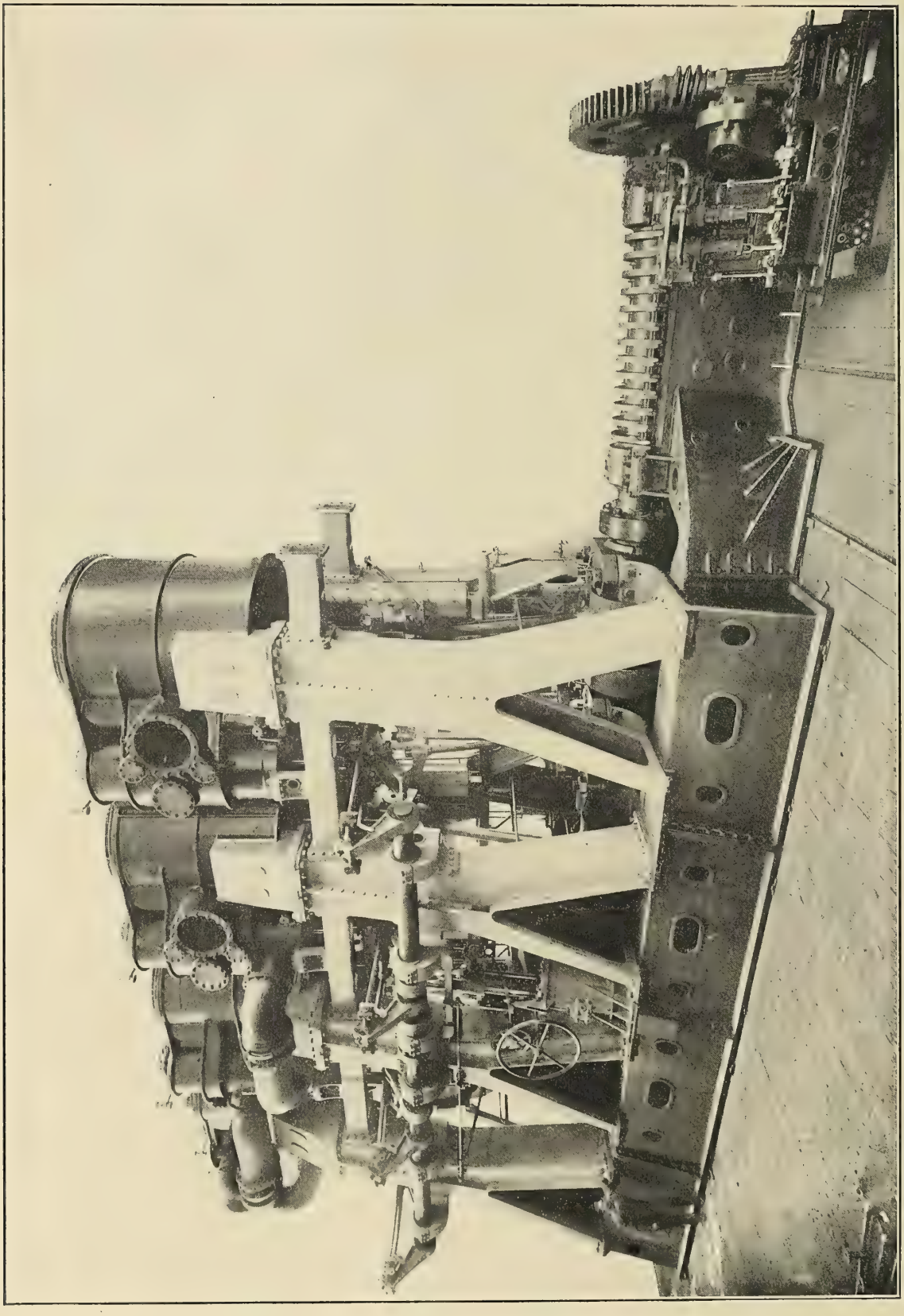
type, but also to reconstruct the whole after end of the ship according to the modern practice of enclosing the propeller shafts within the hull. The new plan, which is now being generally adopted, gives ready access to every part of the shafting between the engine and the tail-shaft stern gland, protects the shafting, and eliminates the resistance due to the propeller brackets. In this reconstruction the rudder and steering gear were to be included.

This radical alteration involved the cutting away of about 150 feet of the ship forward of the stern post. It was a difficult undertaking, because of the massiveness and rigid riveting of the hull, and even more difficult was the removal of the engine foundations and the double bottom. At the same time the bulkheads in the machinery space and bunker casings were also cut away and the shaft tunnels were extended, and all the butt straps of the shell plating were replaced. These separate parts of the scheme of alteration and reconstruction were carried on simultaneously.

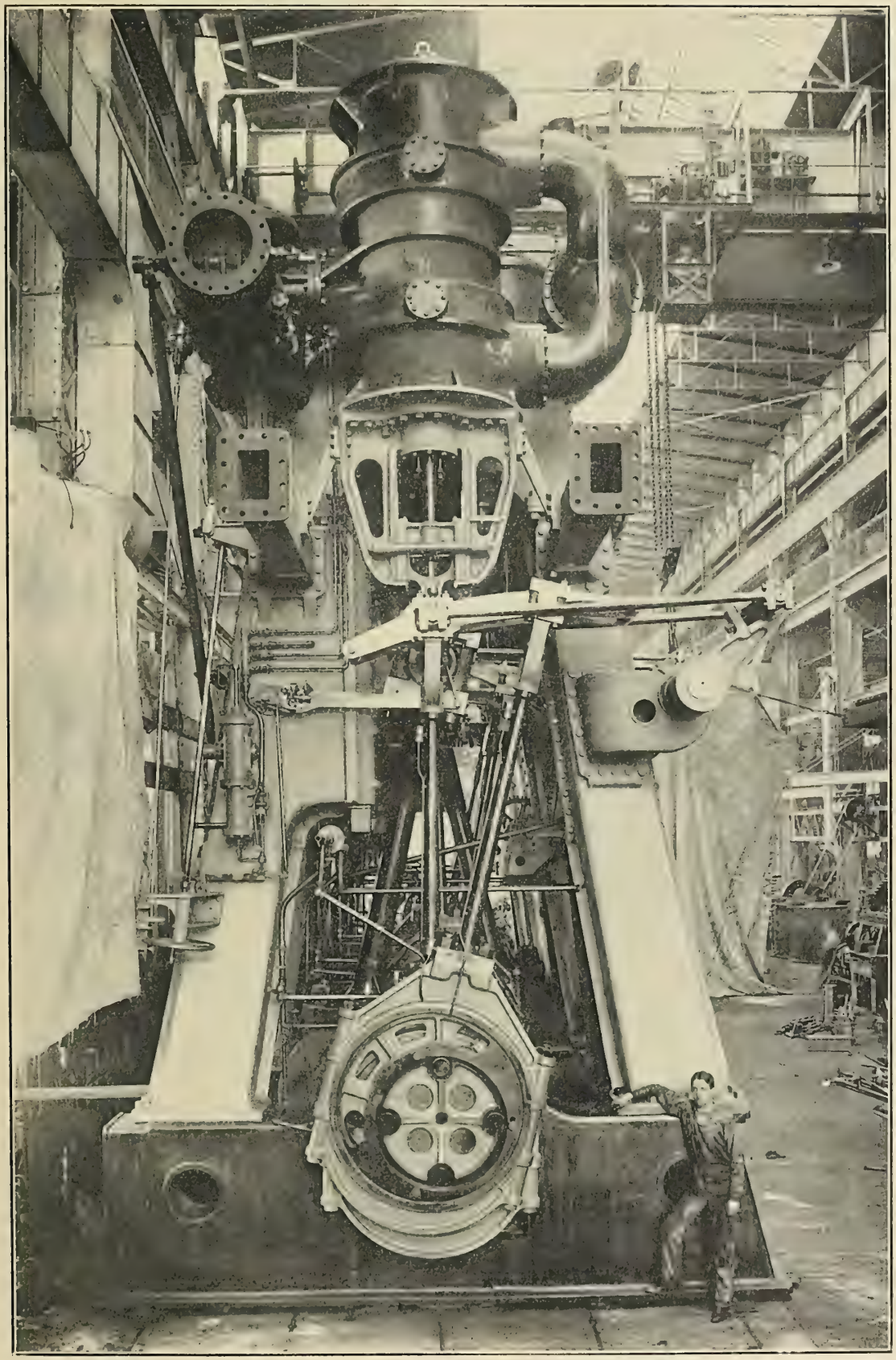
A brief outline of the method of reshaping the after end of the ship may be interesting. The Messrs. Cramp laid off on their mold loft floor the form of the after body of the ship as she was built, and faired in with this the new form of stern, laid down from plans supplied by the *New York's* owners. The extent of the necessary alterations to the ship was then determined and the material ordered; the molds for the new work were made and shipped to the Erie Basin, where the material was to be delivered. While the after body was being cut away for reconstruction, the new frames were bent, bulkhead and floor plates prepared at the Erie Basin, and the new steel castings for the stern frame and rudder were made. When all was in readiness, the frames were erected, faired up in the usual manner, and stringers run and plating laid. At the same time the boiler and engine compartments were being remodeled, the double bottom was reconstructed, the new engine foundation built, and the shaft tunnels were extended to the new stern tubes. When all this work was completed at Erie Basin, the ship was towed back to the Cramp yard at Philadelphia, where new boilers and engines, built at that yard, were put in place on board.

The new arrangement of boilers provides for two instead of three funnels, as formerly, the two new ones being about the size of those on the *Philadelphia*. The space vacated by the middle funnel has been added to the first-class accommodations, where important changes have been made.

The *New York* was the first ship to be provided with



ONE OF THE TWIN-SCREW, FOUR-CYLINDER, TRIPLE-EXPANSION ENGINES, BUILT BY THE WILLIAM CRAMP AND SONS SHIP AND ENGINE BUILDING COMPANY, FOR THE STEAMSHIP NEW YORK.



FORWARD END VIEW OF TRIPLE-EXPANSION ENGINE FOR THE NEW YORK ON THE ERECTION FLOOR OF MESSRS. CRAMP'S MACHINE SHOP.

suites of rooms with private bath rooms, and the success of this new departure was such that it has been carried to a far greater length in the remodeled vessel. She now has many more luxurious private suites. A new, spacious, and handsome smoking room has been constructed in a new deck house abaft the midship saloon entrance on the promenade deck, and is lighted from above by a great skylight of decorated glass. It is divided into alcoves and recesses, and has a stairway to the saloon deck as well as a doorway to the promenade deck, thus making it easily accessible in any weather. Another important change introduced by Mr. J. V. Paterson, naval architect for the company, is the enlargement of the promenade deck, with a view of obtaining wider space for passengers. The result is one of the handsomest and most generous promenade decks in the service. Moreover, the boat deck has been extended over the promenade deck, providing increased shelter for the passengers in rainy weather. The main companionway has been enlarged, and the main dining room, always one of the largest and most beautiful afloat, has been enlarged and redecorated. Many new deck cabins have been added on the saloon deck, and the first-cabin rooms, and indeed, all the interior apartments of the ship, have been thoroughly redecorated and refurnished. At the same time the number of the first-cabin accommodations has been reduced from 520 to 300, so that these passengers in the new ship will have more space and more luxury than ever. The second-cabin passengers have a new drawing room and a new smoking room, while the dining room has been enlarged and the state rooms refitted. The third-class passengers are provided with a well-equipped dining room of their own, and the steerage accommodations generally have been brought up to the most advanced ideas of caring for this important class of passengers.

A feature of the passenger accommodations of the ships of this line has been the systems of forced and exhaust draft for ventilation. The company was the pioneer in this direction, and the original *New York* was very well ventilated. In rebuilding her this question of ventilation has been given due consideration, and been carried out in a manner which secures an abundant supply of fresh air to all parts of the cabins.

A complete new electrical outfit has been installed, and there are three large units and one small one. The plumbing has been renewed throughout, new windlass and warping machinery has been fitted, and also new steam steering gear with two sets of engines.

The machinery consists of two sets of triple-expansion, four-cylinder, direct-acting engines of total 20,000 horse power, and the cylinders are of the following diameters: 42, 66 1-2, 77, and 77 inches, stroke of all being 60 inches. The bed plates are of cast iron, made in four sections, and the front and back columns are of cast steel, each column made in two pieces, flanged and bolted together. The columns are stayed by horizontal distance pieces, and each pair supports a cylinder and its valve, which are made in one casting. There is one piston valve fitted to the forward end of the high-pressure, and two piston valves on the forward side of each of the other cylinders. The valves are operated by Stephenson double link motion, the reversing shaft being at the front. Crosshead guides are on the back columns and of the slipper type. The crank shaft is built up in four interchangeable sections and is of 21 inches diameter. Each section of shaft has two main bearings, and the water service is provided to guides and main journal boxes, top and bottom. In each engine room is installed an independent Blake twin-beam, single-acting air pump with steam cylinders 14 inches diameter and air cylinder 35 inches diameter, the stroke of both being 21 inches. Over half of the pumps are new and of the Worthington type, the main feed pumps being 16 by 10 by 18 inches, of the vertical duplex type. The new propellers fitted have cast-steel hubs and manganese bronze blades.

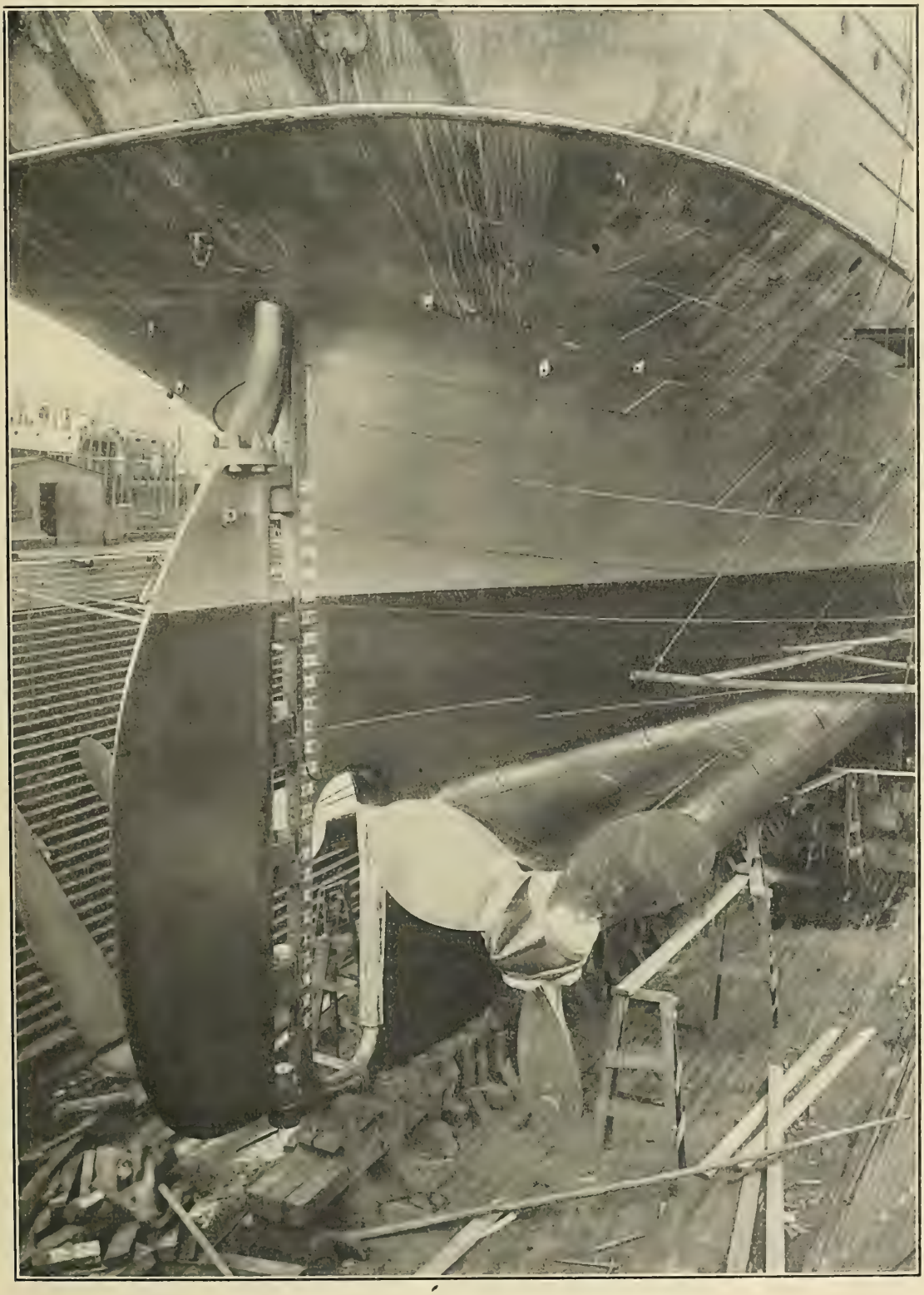
There are six double-end and two single-end boilers, the former being 21 feet long; the latter 10 feet 6 inches long; the diameter of all is 15 feet 10 inches. The double-end boilers have eight Fox furnaces, 39 inches mean diameter, and the single-end four of the same dimension. Thus the total number of furnaces is 64, giving a grate surface of 1,144 square feet. The heating surface of all eight boilers is 47,920 square feet. Forced draft is provided by eight Sturtevant fans, driven by single-acting compound engines.

As this article goes to press, the reconstructed *New York* is sailing on her first passage to Southampton, and it is to be expected that her record will rival that of her sister ship, the *Philadelphia,* which has given remarkably regular service since her reconstruction. The *Philadelphia's* voyage for twelve successive passages westward has been 166 hours 46 minutes, and the average for twelve eastern passages 166 hours 21 minutes. Since rebuilt this ship has made twenty-seven eastbound voyages, sailing from New York on Wednesday, and, except the one passage in January, 1902, when she sailed from New York late on account of snow and fog, she has not failed to land her passengers at Southampton the following Wednesday—an enviable record for any transatlantic ship.

The *New York* and the *Philadelphia,* because of their fine, fair lines and graceful clipper bows, are still considered the handsomest of the ships in the North Atlantic service. The general dimensions are: 560 feet in length over all, 525 feet between perpendiculars; 63 feet 4 inches beam; 42 feet deep; gross registered tonnage, 10,674 tons, and a displacement at mean draft of about 16,000 tons.

Bids for New Battleships.—Circulars calling for bids for three 16,000-ton battleships authorized by the last naval appropriation act have been distributed among the shipbuilders by the Navy Department. The general dimensions and features of these ships are similar to the *Connecticut* and class described in Marine Engineering for April, 1903. Other things being equal, those bidders who guarantee the completion of the work in the shortest time will have the preference; the maximum time allowed for completion is forty-two months. Bids will be opened June 3, and to prevent a recurrence of the complications which arose through the cruiser's contracts a

clause is inserted in the circular as follows: "Bidders are hereby notified that after the bids are opened neither the department nor its bureaus will receive from the bidders, nor from any person acting for them, either directly or indirectly, any communication, plan, or explanation, either verbal or in writing, tending to explain or modify their bids in any way whatever, unless requested by the department."



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Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

THE recent target practice on the *Maine* and the resulting evidences of structural inefficiency in the gun mounts have naturally attracted wide attention from the general public and are exciting the deepest interest on the part of those more directly connected with the naval service. Now that it has all happened it seems relatively easy to explain. The *Maine* and class, as well as all later construction, are armed with the latest type of 50-caliber navy rifle, using smokeless powder and developing 2,800 to 3,000 f. s. velocity. As compared with the earliest types of such guns, developing 2,000 f. s. velocity, this means an increase of energy of over 100 per cent. Compared even with the later preceding types of gun on the *Alabama* and class, or *Kearsarge* and *Kentucky,* the increase is from 40 to 60 per cent. Again, on some of the mounts the length of the recoil cylinder has been slightly reduced, thus reducing the available distance through which the energy can be absorbed, and correspondingly increasing the stress thrown on the structure. Due to these causes in combination, it is not unfair to assume a stress on the structure not less than one and one-half or one and three-quarters times that resulting from the guns used in our previous construction and for which there was available actual experience regarding the sufficiency of gun-mount foundation.

Now, while these various facts were all known and doubtless the possible consequences realized in a general manner, it is undoubtedly true that no one realized the full meaning of this last great stride in modern ordnance. Again, while every one knew that more energy to be absorbed would call for corresponding increase in the weight of structural material employed, perhaps no one realized how near to the margin of sufficiency were the gun foundations used in previous construction. Now that we have before us the results on the *Maine,* it is not difficult to see here and there an intimation that the margin provided in this earlier construction was none too great, and that the present type of gun would require very considerable increase of material in the foundations in order to render them adequate for all requirements. While all of this might have been in a measure foreseen, we do not believe that any one should be blamed because it was not. From the ordnance standpoint the step was enormous, and such steps always cost. Even if the full significance of this step as related to the gun mount had been realized, no one could have told in advance just how much the older type of foundation would need reinforcement in order to render it adequate. Such problems cannot be solved by formulæ nor in any other direct manner. They necessarily depend on experience and only by trial can the final solution be reached. The first trial has been made with the *Maine* and the foundations have been shown to be inadequate. The whole process of the evolution of naval construction is experimental, and this is one of the necessarily experimental steps. No great harm has been done, and some very valuable information has been acquired. In the meantime the foundations on the *Maine* can be adequately strengthened without especial difficulty. It simply means reinforcement, or to some slight extent, perhaps, reconstruction. This can be carried out at no very serious expense, and whatever the amount may be, we may consider it as a fair price for the information thus acquired. For all later construction this information will be available, and where ships are partially or even nearly completed, as in the case of the *Missouri,* immediate steps can and doubtless will be taken to reinforce the gun foundations as indicated desirable from the results observable on the *Maine.*

WITH the launching and rigging of the *Reliance* and the trials of *Shamrock III.* interest in the coming race grows apace. So far as can now be predicted, both boats are improvements over their predecessors. That the spars on *Shamrock III.* were too light for the enormous spread of sail, was shown by the unfortunate accident just reported, when the mast broke close to the deck and in falling killed one of the crew. So far as can be judged, the model of the new boat is but slightly modified compared with that of her predecessor. Somewhat greater displacement and increased ballast, presumably, provide for longer spars and greater sail area, but in the main the characteristics of the new boat are quite similar to those of the earlier *Shamrocks* and are those which have made of them such dangerous contestants for the *America's* Cup.

There seems to be relatively more difference in model on this side of the water than on the other. The bottom of the new defender is said to be flatter and with modifications both at bow and stern as compared with *Columbia* and *Constitution.* The result of these changes can only be known later when the try-out races are held, but all who have had opportunity for observation agree that she will be a fast boat, presumably best before the wind or moderately free, and with perhaps her weakest point when running close.

From the scientific point of view the most interesting feature of this development of yacht design has been the general regularity with which the designers have been able to turn out something each year a little better than the preceding. This rule has met with occasional apparent exceptions, but has held in the main. Now it is certain that within the limitations which surround the design of a cup defender or challenger, such improvement cannot go on indefinitely. The margin left for improvement must, in fact, be constantly growing more narrow, and we must expect that such improvement as can be made will be by shorter and shorter steps. The history of the last three yachts seems to indicate that we are approaching some such limit, and that further progress will be made with perhaps uncertain steps, and that not every attempt can be counted on as an advance on its predecessor. So long as the present conditions remain unchanged it would seem too much to expect any very marked improvement beyond the present designs. The possibilities within these conditions must, in the nature of things, be very nearly exhausted, and more and more in future years we must expect that the results of races within these conditions will turn on special or accidental features. In the meantime the contest between *Reliance* and *Shamrock III.* bids fair to be fully up to the standard of preceding years, and may the better boat win.

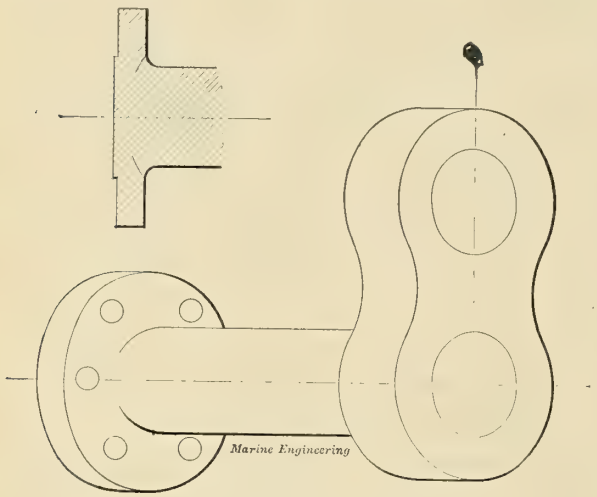
THE condition of the *Maine,* referred to above, is not the only matter in connection with the navy which has awakened anxiety both in and out of the service. The rupture of the gun on the *Iowa,* with its resulting loss of life, is an event far less easy to explain and far more serious in its immediate consequences and in its possible significance. If we mistake not, this is the first gun of the new naval ordnance to burst in such a manner, or even to develop evidence of serious weakness. There have been accidents similar to that on the *Massachusetts* in which the gun was not, at least directly, at fault. Shells have prematurely exploded before, but with no more than local injury to the gun tube. Altogether the accident on the *Iowa* is at present very much of a mystery, and we shall await with great interest the report of the Board of Investigation appointed to examine into the matter. The questions of chief importance are these: Is the result on the *Iowa* chargeable chiefly to the premature explosion of the shell or to weakness in the gun? If the former, can such premature explosion be prevented with a higher degree of assurance than seems now to prevail? If the accident was chargeable to the gun, was the weakness inherent or developed? If inherent, was it due to essential weakness or to initial flaws, and could such have been detected by any possible inspection? If developed, was such weakness or deterioration due to material of indifferent quality at the start, or has the presumably safe number of rounds with modern high-powdered ordnance been placed much too high?

This gun, it is understood, had been fired 125 times, a number well within what was supposed to be a safe life. If the actual life is to be reduced, however, in accordance with the evidence furnished by the *Iowa's* gun, it is most important that such fact should be quickly and clearly established, lest under some unusual strain or accidental circumstance, such as that which occurred on the *Iowa,* other guns now supposed quite safe may unexpectedly fail. By all the laws of ordnance this gun should not have burst as it did. The discovery of the cause and the safeguarding of our modern ordnance from like disaster are certainly duties of the most imperative character.

Breakdown on the Steamer Sloterdyk.

On the 12th of February, this year, while the steamer *Sloterdyk* was on a voyage from Rotterdam, Holland, to Newport News, Va., a heavy knocking was heard in the low-pressure cylinder, which shook the engine badly. The engine was immediately stopped, and after a careful inspection it was found that the intermediate-pressure crank shaft was cracked in the fillet of the after coupling flange, as shown in the sketch. The entire engine staff got to work and disconnected the shaft and strapped it until it was ready for removal.

By this time, according to the account, all the engineers were tired out and had to knock off and give place to the deck department. The captain and crew took the spare shaft, being an interchangeable section, from the bulkhead and shoved it in front of the engine. Then they took the old shaft out and put it in the place where the spare shaft had been stored. The next morning the engineers started to work at regular watches. Key seats for the eccentrics had to be cut, and coupling bolts fitted as there were no appliances for reaming the holes. This work was done while a gale of wind was blowing



FRACTURE IN CRANK SHAFT.

from the south, rolling the ship 48 degrees (?) on her sides and drifting her 550 miles to north out of her course. Sails had been set, but were torn into ribbons. Under these circumstances the job lasted eight days and nights, but was satisfactorily completed. When under steam again the ship made 5 miles an hour, her usual speed being 11 miles. When arriving at Newport News she had been thirty-one days on her trip, which she would make ordinarily in about half that time.

She laid up at Newport News Shipbuilding and Dry-Dock Company for repairs. The entire crank shaft was taken out, the coupling flanges of each section trued up separately in the lathe, the coupling holes reamed, and the shaft, all connected, put in the lathe. Then a cut was taken off the journals of about two papers' thickness. The main-bearing boxes were rebabbitted and bored out in place; also the stern-tube liner was refilled with new lignum vitæ. The repairs took fifteen days, working day and night. M. J. H.

Pump Experience.

"Telephone six!"

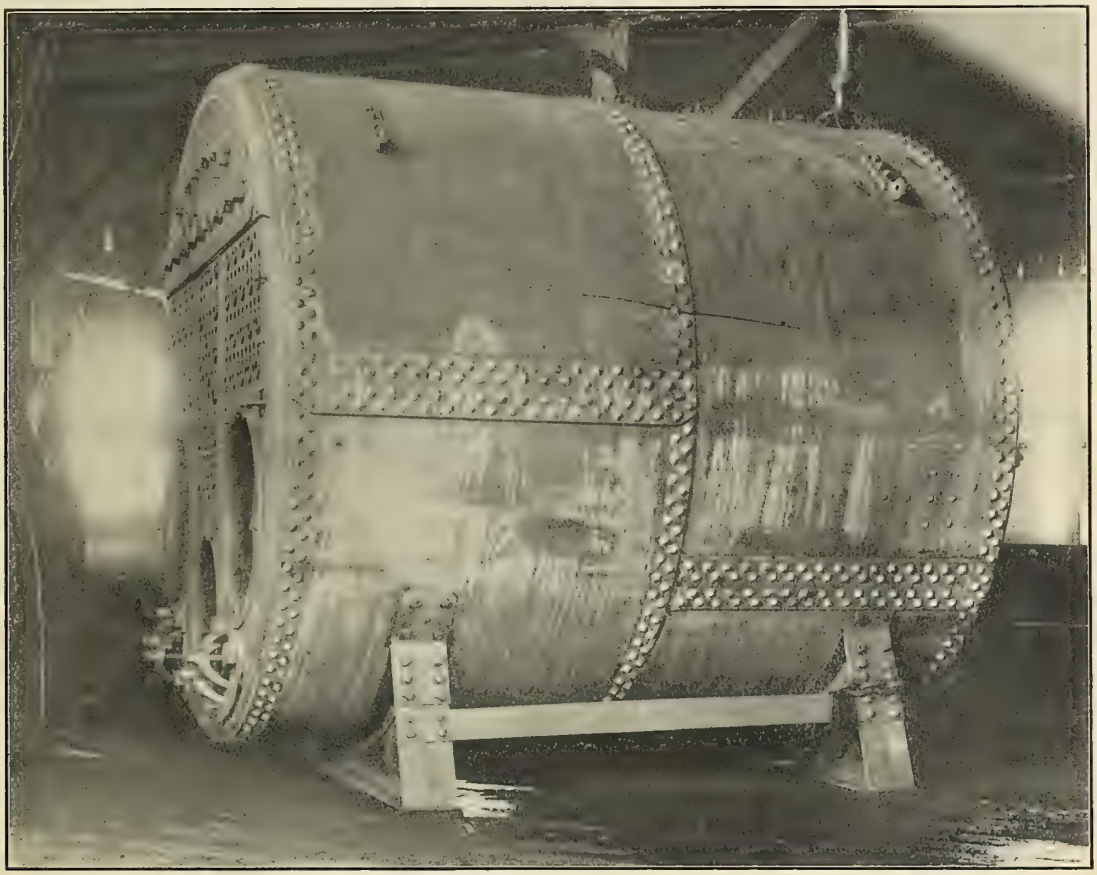
Dropping my work I went to the 'phone, and, inquiring what was wanted, recognized the voice at the other end as a friend of mine, who asked me if I could go down to a sailing ship lying at North Wharf, as a party there wished to consult with me. This being all the information he could give, I told him I would be there in about an hour.

At the wharf I found a very large sailing ship of foreign build. After looking it over I walked toward the boarding ladder, when I met an acquaintance, a stevedore, who asked me what I was doing there and where I was going. Pointing to the ship, I said I was going on board. Walking rapidly from the edge of the wharf, and beckoning me to follow, we went some distance, when he stopped and said: "Don't go on board that ship; there will be some person killed there directly." This surprised me, and I asked what was the matter, to which he replied: "The pumps on that ship have given out completely. They have had workmen from four machine shops working at them, and about all they have done is to take them apart, put them together, and slop lots of water into them and try to make them go, but no use; and awhile ago the 'Old Man' drove the last crowd ashore, and he is now about as near like a crazy man as can be imagined. So now you know where you are going and about what you may expect if you undertake the job and fail." I told him I guessed I would risk it, and he started on his way, but turned back to ask me to leave any message to my loved ones with him in case I did not return. Telling him I did not anticipate any such trouble, I made my way to the ladder and went on board. I had scarcely touched the deck when I was caught very roughly by the shoulder, and, looking to see who my captor was, found myself in the hands of a stout, much-bewhiskered man, who, before I had time to think much, said in broken English, "You vex bumps?" I told him I came to see or talk of something here, and supposed that was it; on which he dropped his hold on me and started on a run aft, at the same time beckoning me and telling me to "coom." On getting to the part of the ship just forward of the poop, he stopped, and, pointing to something near the port side, said, "There it," at the same time keeping up his motions and gesticulating in a most frantic manner. Going up to where he pointed, I found a pump of the following description:

A block of oak about 16 inches square projected about 3 1-2 feet above deck, the outside of which was used for mooring the ship. The center was bored out and a copper lining inserted, forming the pump barrel, 7 inches diameter and about 7 1-2 feet long, which was joined to a 4-inch suction pipe by a tapered portion. A common plunger with hinge valve in it was used, and the bottom box was fitted with a hinge valve, which was driven tight in tapered part. On the other side of the ship was a similar pump, and these pumps were used to remove bilge water when the ship was under sail pressure and was lying over on either tack. The plunger and lower valve boxes were lying on deck, and a glance at them showed me that the trouble was not there and that I must look elsewhere for it. All this time the captain was following me, constantly asking, "You see

trouble? You vex?" Finally I turned to him and asked him to get me a mirror. "Vot?" he said. I told him a looking-glass, at the same time holding my hand up in front of my face. He was some time trying to understand me, but finally did, and then I thought my time had surely come. Looking at me, and acting as wildly as can be imagined, he said: "You not butty, vot for you vont see you? You vex bumps." I tried to tell him that was what I wanted the mirror for; but it was no use, he would not pay any attention, but went on with his raving at me and the "mirr." Finally another man came on board, and, coming near where we were, told me in very fair English he was the mate, and on my asking him for a mirror he went to his cabin and got one. The sun was shining very brightly, and it happened to be in a good position for me, so, taking the mirror and holding it over the pump barrel, I got a ray of light down a long way into it, sufficiently far and bright enough to show me that the tapered part, where the lower box went in, had parted at the brazing and was causing all the trouble. Going over to the other pump, I found it in the same condittion, so, coming back, I called the captain, and placing the mirror in the right position, I asked him to look in. He did so, and noticed the break as quickly as I had; then, taking the mirror out of my hand, he ran over to the other pump and tried to look into it, but could not get the glass in position. I went over and placed it for him, and, after looking, he turned to me and said, "That do. You go. I get bumps vex now," at the same time motioning me toward the ladder. I told him not to hurry too much, there was something else to fix now; and on his asking, "Vot vex now?" I told him I wanted to be fixed for my time, which required to be done with a ten-dollar bill. He immediately got in his tantrums again, and refused to pay, telling me: "I get bump vex now; you no vex." I made out to him my charge was for knowing and finding out the trouble, and he could do what he liked about fixing them. He finally came to terms, and I left him.

George H. Waring.



RUPTURED SHELL PLATES OF A SCOTCH BOILER SUBJECTED TO A TEST.

Boiler Ruptured Under Test.

A most interesting photograph has been received from the Polson Iron Works, Toronto, Canada, of a marine boiler which burst in testing. The dimensions of the boiler are as follows: Shell 11 feet 6 inches diameter inside large course, by 13 inches long outside of heads. It contained 192 tubes 3 inches diameter by 10 feet long, and three Morison corrugated furnaces 35 inches inside diameter by 9 feet 11 1-2 inches long. These were of the interchangeable type and led to three separate back connections, with all the flat surfaces stayed to meet the requirements of Lloyd's and the Canadian Inspection Acts for a working pressure of 152 pounds per square inch. It was tested to 228 pounds cold water and was to be operated by induced draft.

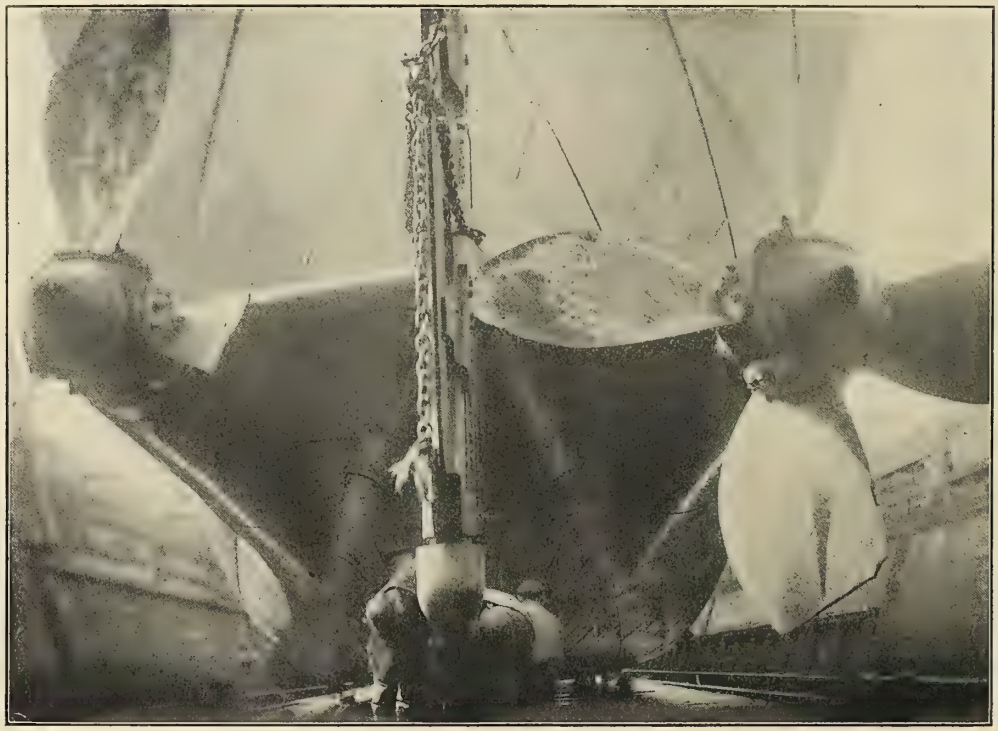
After the boiler had been completed and tested at the works up to 300 pounds cold water, the joints in one of the manholes failed, necessitating making another test. After making this joint good, another test was

made, when at 270 pounds, without warning, the boiler burst, as can be seen in the photograph. It appears to have started at the circumferential joint and split to both ends, one crack ending at the first rivet in the circumferential seam around the head, and the other ending in one of the staybolt holes around the combustion chamber. The thickness of the plates was 1.023 inches, the longitudinal seams being butted and double strapped and double riveted, with a joint equal to 70 per cent. of the solid plate, and all holes drilled in place. The quality of the steel was best quality flange steel of 60,000 pounds tensile strength, and, as can be seen by the photograph, the boiler burst at what is supposed to be the strongest point, the longitudinal seams showing no signs of weakness or straining of any kind, none of the flat surfaces showing any signs of bulging, nor any of the stays leaking at any point. Two gages were attached at the time of testing, one on the boiler and the other on the hydraulic pump, and both indicated the same pressure, viz., 270 pounds.

After the bursting of this boiler an investigation was held by the Board of Canadian Steamboat Inspectors and also by Lloyd's surveyors. The Canadian Steamboat Inspectors condemned all the shell plates, and the builders were therefore compelled to cut the boiler all to pieces and rebuild it again, getting new plates from the same mill. It then stood the test several times without failure.

Regarding the plates in the boiler that failed, it may be said that, in attempting to straighten these, which was done under an hydraulic press, they broke clean across just as if they were glass, and showing a number of hair cracks inside of the plates at least 3-16 inch deep. These hair cracks were particularly noticeable as the water had worked into them and they were rusted. Attempting to straighten and cold-bend these plates, they failed every time, but when pulled in the testing machine they gave over 60,000 pounds tensile strength. The steel supplied by the same mill to replace the broken plates was noticed in working to be of very much softer character and much more easy to bend, although supposedly all the same quality, viz., flange steel 60,000 pounds tensile strength.

Lloyd's inspectors and the Canadian government inspectors cut all the parts near or adjacent to the fracture and the builders endeavored to obtain from the inspectors a copy of their report on the test. Strange to relate, the inspectors refused to submit the report, stating that they could not give up this test without the permission of the steel company who manufactured the steel.



BROKEN PROPELLER BLADES ON THE STEAMSHIP NECKAR.

Broken Propeller Blades.

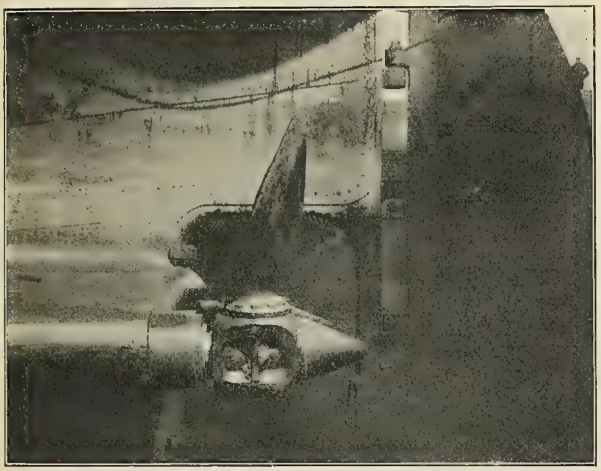
Editor Marine Engineering:

Most of your readers probably saw newspaper accounts of the accident to the North German Lloyd steamer *Neckar* about a year ago, and will no doubt be interested in the accompanying photographs, taken by Captain A. Harrassowitz while the steamer was undergoing repairs in dry-dock at Halifax. The *Neckar* encountered one of the worst storms which have swept the North Atlantic in years, and, having lost three blades of her port and one of her starboard propeller, and broken her steam-steering gear and rudder stock, was for nine days all but helpless in the terrific seas. It is thought that the port propeller struck some floating wreckage, breaking three blades, and that one of the blades or part of the wreckage was thrown so as to

break the rudder stock and one blade of the starboard screw.

It is interesting to note—as shown in one of the photographs—that one of the blades, instead of breaking at the root, as is generally the case, carried away part of the hub.

In spite of her severe injuries and the terrific storms, which continued with unabated force, the *Neckar* proceeded to Halifax under her own steam, being steered by improvised gear, and covering the 700 miles in nine days.



BROKEN CAST-STEEL HUB OF THE NECKAR.

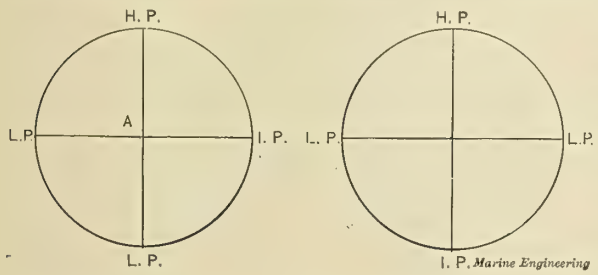
A complete description of the *Neckar* was given in Marine Engineering in February, 1902, issue.

P. G. L. Hilken.

QUERIES AND ANSWERS.

Q. 149.—Is there any advantage on a four-cylinder triple by placing the cranks in certain position, as in figures below?

A.—The question of placing the cranks in one arrangement or another, as illustrated, has reference chiefly to the inertia forces and to the general problem of engine balancing. It is impossible, in the general case, to state which of the two would be the better. The final result would depend on the various details of the case and could



not be predicted without a study of all features entering the problem.

The arrangement with the two low-pressure cranks opposite is on the whole more frequently met with than the other, but it might easily result in a special case that the latter method would prove the better of the two. In addition to the influence on the problem of engine balancing, the distribution of the cranks will also influence the smoothness of the crank effort ; the latter, however, is of smaller importance than the former.

Space forbids a more detailed discussion of the question, as any attempt to present the matter fully would require a detailed study of the entire problem of inertia forces and engine balancing.

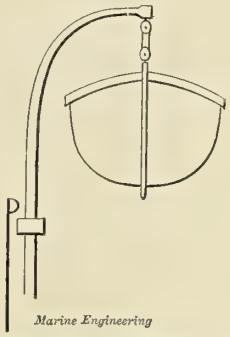
For an excellent discussion of these problems you are referred to a book, recently published, on the "Balancing of Engines," and of which Professor W. E. Dalby is the author.

Q. 148.—Will you kindly advise, through your magazine, the best and most practical formula used in calculating the size and strength of ordinary boat davits, as per sketch? W. E. J.

A.—Let a denote the overhang of the davit in inches.
W " " weight it is to support.
d " " diameter in inches.
K " " safe bending stress.

Then, assuming that the davit is round in cross-section, the principles of mechanics give us the formula:

$$d = 1.366 \sqrt[3]{\frac{Wa}{K}}$$



In using this formula judgment is needed in connection with the selection of a suitable value for the stress K. As the load is often quite variable, the working stress should be taken low to provide for all contingencies. This would indicate for the ordinary davit a value 4,000 to 6,000. Thus, for example, if W, or one-half the boat, equals 1,200 pounds and a equals 3 feet, then with K equaling 5,000 pounds per square inch we have:

$$d = 1.366 \sqrt[3]{\frac{1,200 \times 36}{5,000}} = 1.366 \times 2.05 = 2\ 8 \text{ ins.}$$

New Steamships Purchased.—The Pacific Mail Steamship Company has purchased from the Atlantic Transport Line the two steamships *Minnelora* and *Minnuahta,* which are now under construction at the New York Shipbuilding Company's yard, Camden, N. J. The ships are not yet off the stocks, but as soon as completed will be placed in the transpacific service. Since these vessels were ordered the Atlantic Transport Line, it will be remembered, has been merged into the International Mercantile Marine Company.

Outboard-Turning Screws.—Screws on the new battleships *Vermont, Kansas,* and *Minnesota* will have outboard-turning screws. The naval board of construction has made this change to the former practice in view of observations made in the recent West Indian cruise of our fleets. It was noticed while slightly increased speed was attained on ships with inboard-turning screws, yet the manœuvering qualities were not as good as on ships with outboard-turning screws.

ENGINEERING SPECIALTIES.

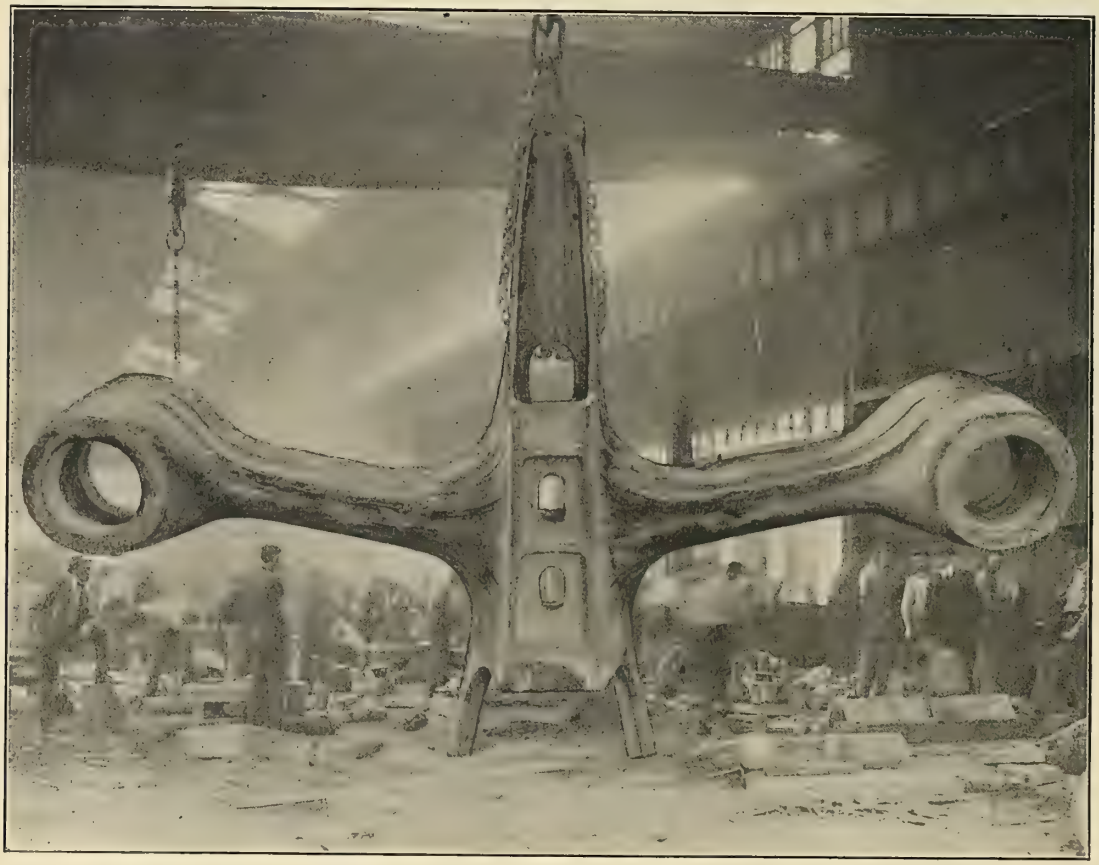
Heavy Steel Castings.

Possibly nothing which entered into the construction of the great Pacific ships building at New London illustrated the development of American manufacturing facilities more aptly than the immense steel castings which were required for the hull construction. All of the hull castings for the two ships were supplied by the Seaboard Steel Casting Company, of Chester, Pa., and in making these immense masses of steel, work of a magnitude was undertaken which had never before been attempted in cast steel.

There were thirteen principal castings for each ship—two pieces for the stem, four for the stern post, the two enormous struts, and five pieces in the rudder and rudder post. The aggregate weight of these castings for each ship is over 150 tons, and yet they were machined to fit up as accurately as though they were the small pieces, by comparison, required in an engine. The rudder and post, as bolted together, were over sixty feet in length, and to make all these enormous castings and fit them together, adjusting the bolts and machining them to line up exactly, was the Seaboard Steel Casting Company's share of the work.

The immense spectacle frame, consisting of a central piece and two struts, weighs alone over fifty tons, and yet these castings and the palms of the struts to the great section of the stern post were fitted up and bolted together so accurately that the deviation was less than would be expected in the struts for a one-hundred-foot yacht. The whole undertaking was most creditably carried out, and has attracted a great deal of attention from marine engineers and mechanics.

Unfortunately, no accurate photographs of these big castings could be secured, but the illustration shows the spectacle frame cast in one piece at the Seaboard foundry for one of the large new ships for the Atlantic Transport Company. It shows the size of this steel casting, which weighed about twenty-five tons finished. These castings are all made from the highest-grade open-hearth steel, subject to Lloyd's specifications and tests, and the metal in them stands the same tests as are required for steel forgings.

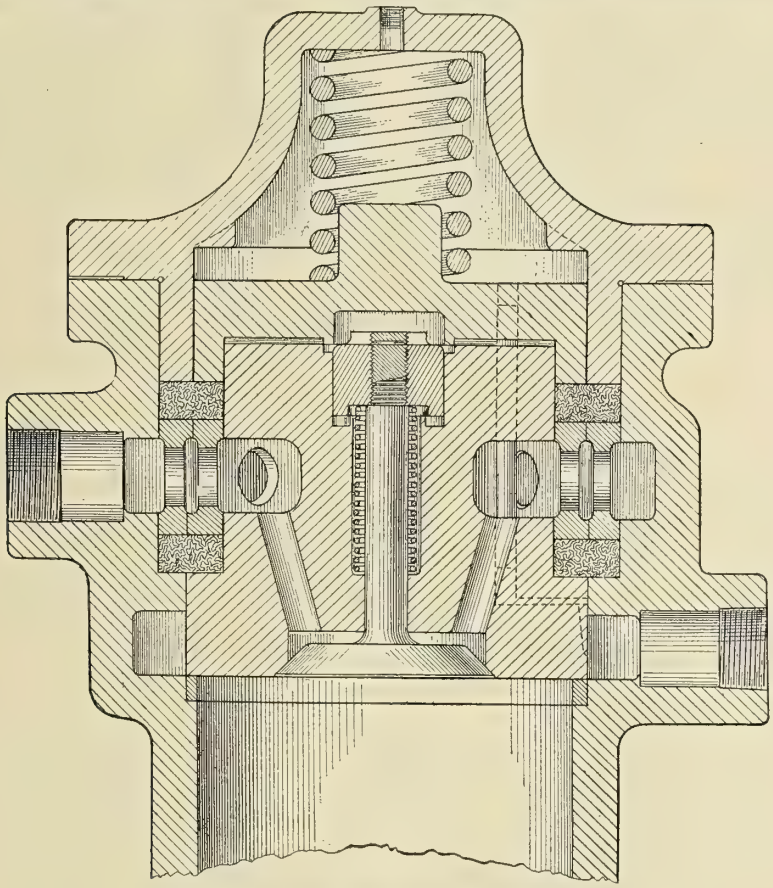


CAST-STEEL SPECTACLE FRAME FOR ATLANTIC STEAMSHIP, CAST BY THE SEABOARD STEEL CASTING COMPANY.

Brunswick Compressor Valve.

The valves of the compressors of the Brunswick Refrigerator Company, New Brunswick, N. J., are a radical departure from the old-style conventional types. The suction valve is carried on the inside of the discharge valve and has its seat on the face of the latter. By reason of this construction the suction valve is of a very large diameter, thus preventing excessive lift, while the discharge valve is made the full diameter of the cylinder, virtually becoming a lifting head, so that there need be no clearance. In fact, the piston is set to run a little above the discharge-valve seat. Near the end of the stroke the piston is moving with a very low velocity, being at rest at the point of reversal. By having the piston stand above the valve seat at this point of reversal, the discharge valve is forced by its spring into contact

with the piston and is carried by the piston to its seat, thus lessening to a large measure what is known as "the slip of the gas," that is, the rushing of the compressed gas back into the cylinder on the suction stroke before the discharge valve closes. The pressure to which the gas must be compressed before the discharge valve opens, which is a very important point, can be accurately decided upon, so that, with a given width of valve seat and a given condenser pressure, it is simply a question of the ratio of the area of the valve seat to the area of the face of the valve. The greater this ratio, the greater the pressure to open the valve against a given condenser pressure. With a small discharge valve this may be very great, but by making the valve the same diameter of the cylinder this ratio is the smallest possible.



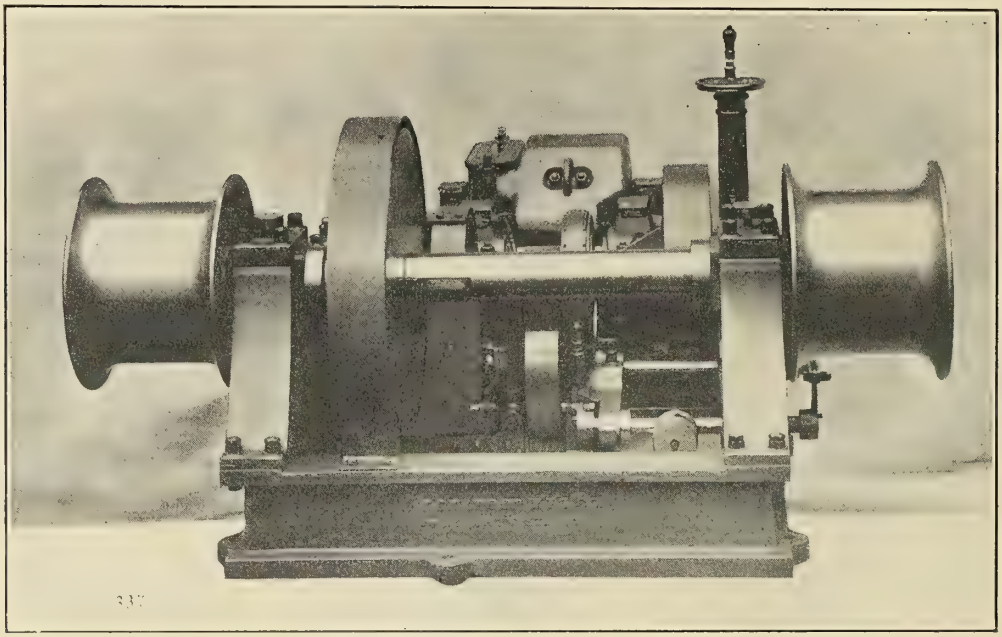
COMPRESSOR VALVE FOR BRUNSWICK AMMONIA COMPRESSOR.

The manner in which the discharge valve is carried in the upper bore of the cylinder involves the principle of the diaphragm. The valve is held suspended in its position by two thick rings of vulcanized rubber, especially compounded to resist the combined action of oil and ammonia. These rubber rings are separated from each other by two spacing rings of cast iron, so made as to allow the suction gas to enter the suction chamber formed around the discharge valve. From this chamber it enters the cylinder through a number of holes drilled in the discharge valve. By use of this diaphragm construction the entire area of the back of the discharge valve is *not* exposed to discharge pressure. There is a small area, formed by a shoulder around the valve, upon which there is suction pressure only, it being protected from the discharge pressure by the rubber packing rings. The discharge-valve spring supplies the pressure to balance and seat the valve—the amount of spring pressure for this depending on the area of the valve thus protected from the discharge pressure. By this arrangement is obtained one of the salient features of the valve, that is, the ability to limit the pressure pumped against without any exterior safety valve.

It sometimes happens that an engineer will start up a machine and neglect to open the valve in the discharge line. Under the circumstances a very few revolutions of the machine will produce a tremendous pressure in the line pipe and cylinders and a corresponding undue strain on the shafts, rods, and pins. With the Brunswick machine such a condition of affairs is quite impossible, for the reasons above stated. Start up a Brunswick machine, connect it with a receiver of any size, and when a given pressure is reached—fixed by the discharge-valve spring—the discharge valves on both cylinders stand open and you simply see-saw the gas from one cylinder to the other, consuming no more power than is necessary to overcome the friction of the machine. Of course, with an ammonia compressor this spring is made of sufficient strength to provide for all possible condenser and suction pressures. A tool-steel ring is forced into the cylinder to form the discharge-valve seat, while the valve itself is cut from a solid bar of machine steel. The materials used are the best and the workmanship first class in every particular.

Improved Electric Ship Winch.

The accompanying engraving illustrates the new improved form of ship's winch which has been brought out by the Lidgerwood Manufacturing Company, 96 Liberty street, New York, N. Y., to supply the demand for a modern first-class machine. It is driven by the latest form of armored motor of the General Electric Company, and has all improvements. The controller is of the railroad type, and in the machine shown is located between decks, together with the resistances, while the operating handle is mounted upon a special post containing a contact, etc. The winches are connected by two sets of gearing which give two different speeds, either being thrown in by moving the lever. This is provided with the Lidgerwood thumb latch and detent engaging a ratchet quadrant.



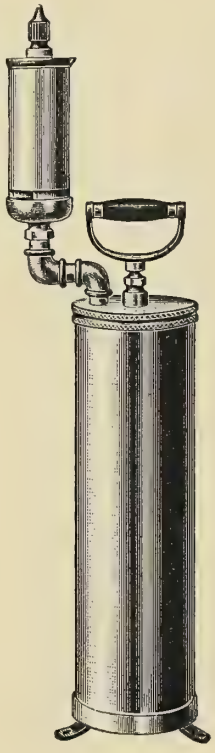
LIDGERWOOD ELECTRIC-DRIVEN SHIP WINCH.

There are in all 76 winches of this style supplied the Eastern Shipbuilding Company for the *Minnesota* and her sister ship the *Dakota,* 52 of them being equipped with 25-horse-power motors with a capacity of 3,000 pounds lift, and the remainder with motors of greater horse power for hoisting heavier weights.

A Launch Whistle.

A whistle seems to be a small item in the equipment of a launch, yet in this there are many points where a good design will overcome the difficulties and annoyances attendant on a whistle of poor design. The whistle here illustrated is one which is blown promptly by pulling the handle of the pump; thus it is independent of an air tank or the engine, and is always ready for use. The pump is of large dimensions, and gives a volume of air sufficient for the blast to be heard a long distance off; in fact, the whistle has been heard for a distance of two miles.

The whistle is made in a four-tone chime, and can be adjusted to a shrill high tone or to a deep low tone, as desired. It is made from best material throughout and guaranteed in every way. The finish is also carefully attended to.

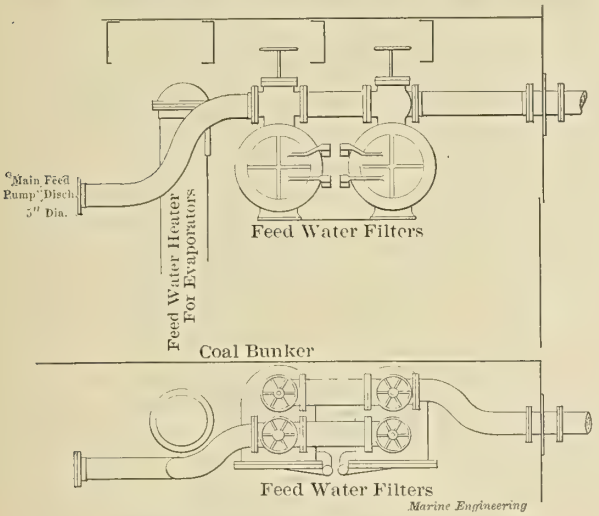


HAND PUMP WHISTLE FOR LAUNCHES.

Many of these whistles have been sent abroad. They are made by the Bowen Manufacturing Company, Auburn, N. Y.

New Feed-Water Filters.

The patent feed-water filters and oil extractors installed on the *Minnesota* and her sister ship, building at New London, Conn., were supplied by the Blackburn Smith Company, 29 Broadway, New York, N. Y. These filters are of the unit type of chest connected up in parallel, there being two chests to each main feed pump, or four chests in each vessel, one set on the port side and one set on the starboard. Each chest has a filtering arrangement consisting of 19 brass cartridges, perforated with 3-4-inch holes, and having a total filtering capacity per unit of 6,250 I.H.P. The accompanying sketch shows the method of connecting the units, from which it will be seen that either unit can be shut off for removing foul cartridges and replacing with a clean spare set, which is sent with every filter, while the supply of feed water is kept constant and filtered through the second chest. These filters are placed on the discharge side of feed pump, and are accordingly subject to boiler pressure. The filtering medium consists of a stocking of heavy linen "terry" or Turkish toweling, which is drawn over the cartridges and clamped at each end by cartridge plates.

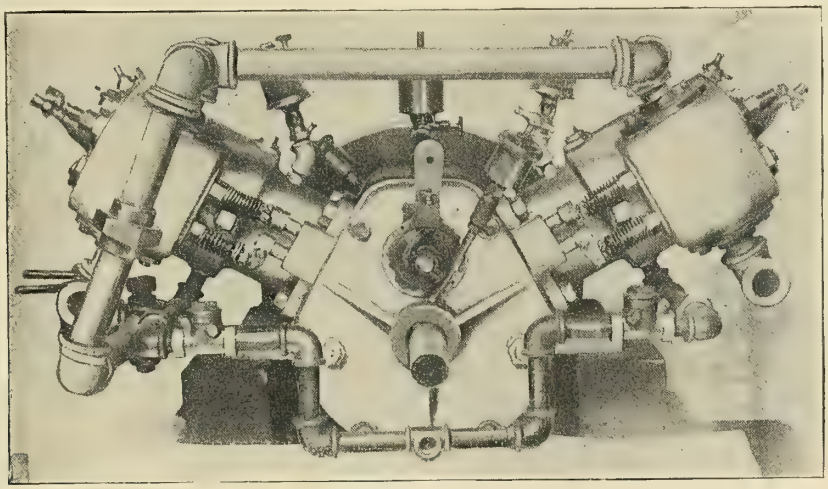


ARRANGEMENT FOR PATENT FEED-WATER FILTERS.

The entire set of filters were tested to a hydrostatic pressure of 650 pounds per square inch. Each unit can be entirely cleaned in 10 minutes. The absolute necessity of preventing oil and grease from entering boilers, especially water-tube boilers, is one of the most important points to be considered in equipping a modern vessel. Not only will oil quickly ruin boilers, but a large increase in fuel is entailed if the boilers are coated with a non-conducting matter such as oil deposit. This is stated to be the largest installation of marine feed-water filters ever built in the United States, aggregating 50,000 I.H.P.

The Burlingame Motor.

The especial features of this gasoline engine are its flat form and control of speed. Its flat form makes it especially adapted to auxiliary yacht use, as it will fit the bilge of a boat and allow of its being placed low, and in most cases under the cockpit floor, out of sight and out of the way, leaving the cabin clear and not filling it with the smell of oil and naphtha. The speed of the engine is under perfect control at all times, and this is accomplished either by the time of sparking or by governing. The time of sparking is regulated by the movement of a lever which projects upward between the cylinders. This lever may be connected to another lever in any part of the boat, so that the person steering may have control of the engine without moving from the wheel. As to governing, any throttle governor may be used. The engine will run steadily at any speed from 200 to over 1,000 revolutions per minute.



COMPACT, LIGHT-WEIGHT GASOLINE ENGINE.

Ignition is by the jump-spark system, and the contact surface being long gives a vibrating spark of long duration, insuring ignition. The contact points are outside of the engine, where they may be reached at any time and cleaned while the engine is running; and if either spark plug needs cleaning, it may be taken out and cleaned without stopping, as the engine will run on either cylinder alone.

The cylinders being opposed to each other allow the engine to run with almost no vibration, as the explosion on one side is cushioned on the other. The valves are all mechanically actuated, overcoming one fault where the intake valve is operated by suction, as with a suction valve: unless the valve stem is covered air-tight, the wear of the valve-stem guide makes a leak, so that air is taken into the explosion chamber, causing the engine to miss.

Another feature of this engine is the accessibility to the working parts. The cams, gears, etc., are all contained in the crank-case cover, and unscrewing the bolts that connect this to the crank case, and sliding the cover back on the shaft, gives access to all the cam gears, and opens the crank case the full size so that the crank connections may be easily reached. The engine is thoroughly cooled, as the cylinders, cylinder heads, and valve case are all water-jacketed, the water inlet being at the bottom of the cylinder and the outlet from the top of cylinder head. This engine is one of the smallest and lightest engines for marine use on the market, compared with power developed; the dimensions being, total width across both cylinders, 35 inches; from front of flywheel to after side of crank case, 16 inches; height above bed logs, 14 inches; total height from bottom of flywheel to top of piping, 21 inches; and weighs 375 pounds.

This engine, with aluminum crank case for reducing the weight, has proved very successful for automobile use. It is made by S. C. Burlingame and Company, 49 Washington street, Providence, R. I.

ANCHOR SWIVEL.

Swivel for Holding Anchors.

A patent swivel for holding anchors is manufactured by R. S. Davis, Camden, Me., and as here illustrated consists of a large flat swivel with shackle at either end; one shackle is attached to the anchor and the other to the anchor chain. On each side of this swivel are flat pieces of iron, about two inches thick, which are connected at the ends. Through these end pieces the swivel bar runs and is connected to but one crosspiece. A steel spring about one inch in diameter is coiled around the bar between the two end pieces. It is thus seen that the spring acts as a cushion for any strain which may be transmitted to the anchor, as it will contract when the chain is pulled. This device will prevent the chain from fouling and the anchor from dragging when the ship is riding the waves, as no sudden jerks come upon the anchor. The swivel is made in several sizes to withstand from 10 to 90 tons.

LAUNCHES.

Steamboat Asbury Park.—On March 27 the steamer *Asbury Park* was launched at Philadelphia from the yard of Wm. Cramp and Sons' Ship and Engine Building Company. The vessel is for the New York and Sandy Hook service of the Central Railroad of New Jersey, on which the steamers *Monmouth* and *Sandy Hook* now run. The *Asbury Park* is larger than these vessels, being 306 feet long, 61 feet 4 inches beam, and is propelled by high-power, twin-screw, triple-expansion, four-cylinder engines.

Steamer City of South Haven.—The new steel steamer of the Dunkley-Williams Line, built for the South Haven service on Lake Michigan, was recently launched from the Craig Shipbuilding Company's yards, Toledo, Ohio. The general dimensions of the vessel are: Length, 260 feet; beam, 40 feet; depth, molded, 16 feet; draft, light, 12 1-2 feet. The vessel is built of steel throughout and will be double-decked. The machinery consists of triple-expansion engines of 3,000 horse power and six boilers with a working pressure of 225 pounds. There are one hundred state rooms, all of which open outside and are provided with running water and telephone service, the latter connected with the purser's office. Considerable interest has been taken in the naming of this ship, as a rival company is building a vessel for the same service and expected to use the name *City of South Haven.*

Armored Cruiser West Virginia.—On April 18 the armored cruiser *West Virginia* was launched with elaborate ceremonies at Newport News from the yard of the Newport News Shipbuilding and Dry-Dock Company. The keel of the *West Virginia* was laid September 16, 1901, and the contract calls for her completion January 24, 1904. Her length over all is 502 feet; extreme breadth, 69 feet 6 1-2 inches; mean draft, 24 feet 1 inch; displacement, 13,680 tons. She will be driven at a speed of 22 knots by twin-screw, vertical, triple-expansion engines, steam being furnished by Babcock and Wilcox boilers. The main batteries include four 8-inch B. L. R., fourteen 6-inch R. F. guns ; and the secondary battery consists of eighteen 3-inch R. F. G., twelve 3-pounder R. F., and eighteen smaller guns ; the water-line belt of armor varies from 5 to 6 inches; the turrets from 6 to 6 1-2 inches, and the barbettes are of 6-inch armor. A large delegation of West Virginia officials attended the launching. The ship was christened by the daughter of Governor A. B. White.

PERSONALS.

George Uhler, former president of the Marine Engineers' Beneficial Association, has been appointed Supervising Inspector General by the Secretary of the Treasury, L. M. Shaw, in place of James A. Dumont, resigned.

Frank A. Jones has been appointed National President of the Marine Engineers' Beneficial Association.

Samuel Shaver and J. P. Burg have been appointed Corresponding Secretaries 41 and 78, respectively, of the Marine Engineers' Beneficial Association.

John Gardner, formerly with the Wm. R. Trigg Company, Richmond, Va., has accepted a position with the Morgan Iron Works, foot of East Ninth street, New York, N. Y.

C. M. Andrews, who formerly held a position as draftsman with the Wm. R. Trigg Company, Richmond, Va., has taken a position in the drafting room of the New York Shipbuilding Company, Camden, N. J.

Alfred H. Knight, who was hull draftsman in the New York Shipbuilding Company, Camden, N. J., has taken a corresponding position in the Great Lakes Engineering Works, Detroit, Mich.

George Howard Paul, who was second assistant engineer in the United States Revenue Cutter Service, is now acting warrant machinist in the United States Navy, serving on U. S. S. *Kearsarge.*

J. Henry Stannard, formerly engine draftsman of the Wm. R. Trigg Company, Richmond, Va., is now an engine draftsman in the New York Shipbuilding Company, Camden, N. J.

William Knapp Hathaway has gone with the New York Shipbuilding Company as draftsman. His former position was as draftsman with the American Pipe Manufacturing Company, Philadelphia, Pa.

M. J. Hekking, who was formerly in the engine-drafting room of the Wm. R. Trigg Company, Richmond, Va., is now with the Newport News Shipbuilding and Dry-Dock Company, Newport News, Va.

Walter Wythe Young, formerly marine engine draftsman with the Midvale Steel Company, Nicetown, Pa., has gone to the New York Shipbuilding Company, Camden, N. J., where he has accepted a position as draftsman in the engine department.

Olaf P. F. Briggs, who held a position as draftsman with the Anchor Engine and Machine Company, Pittsburg, Pa., has taken a position in the drafting rooms of the New York Shipbuilding Company, Camden, N. J.

Charles S. Philips, who was formerly engine draftsman with the Perth Amboy Shipbuilding and Engineering Company, Perth Amboy, N. J., has accepted a position with the Blackburn Smith Company, 29 Broadway, New York, N. Y., as engine draftsman.

Arthur P. Allen, designer and supervising engineering draftsman with Moran Brothers Company, is now senior partner of the firm of Allen and Ballord, naval architects and marine engineers, 104 New York Block, Seattle, Wash.

G. M. Kohler, assistant to consulting engineer of the Columbia Iron Works, St. Clair, Mich., has taken a position as assistant to the chief engineer of the U. S. Revenue Cutter Service, Washington, D. C.

Ethelbert Belknap Morril, who was formerly a mechanical draftsman with the B. F. Sturtevant Company, Boston, Mass., has gone to the New York Shipbuilding Company, Camden, N. J., where he has taken a position as mechanical draftsman.

Ralph Entriken has left the drafting room of the Westinghouse Electric and Manufacturing Company, Pittsburg, Pa., to accept a position as draftsman with the New York Shipbuilding Company, Camden, N. J.

Ernst G. Ekstrom, formerly marine engine draftsman with the Newport News Shipbuilding and Dry-Dock Company, Newport News, Va., has taken a position as draftsman in the engine department of the New York Shipbuilding Company, Camden, N. J.

Carl J. Roelker has left Wm. R. Trigg Company, where he was employed as a mechanical draftsman, and taken a corresponding position with the New York Shipbuilding Company, Camden, N. J.

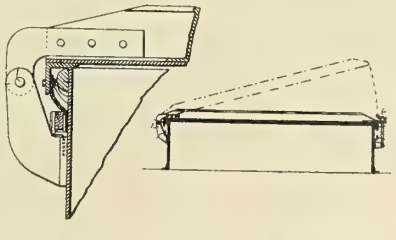
F. Carl Kohler, who was formerly a draftsman of Morse, Williams and Company, Philadelphia, Pa., has taken a position as draftsman with the New York Shipbuilding Company, Camden, N. J.

William A. Ridout has gone with the New York Shipbuilding Company, Camden, N. J., as draftsman. His former position was as engine draftsman with the Wm. R. Trigg Company, Richmond, Va.

Battleship Connecticut.—On March 10 the first keel plate of the battleship *Connecticut* was placed in position in the Brooklyn Navy Yard, and the race between government and private warship construction was begun. A few days later a labor agitator intimidated the men of a private concern who were erecting a crane to be used in constructing the battleship, and the men quit work. This matter has been taken up at Washington and the government has now provided a steamboat on which the men engaged in work on the crane will be taken care of, and a corps of marines will protect the workmen from any interference.

SELECTED MARINE PATENTS.

722,215. COVER FOR VESSELS' HATCHWAYS. EDWIN W. DERUSETT, TYNEMOUTH, ENGLAND.

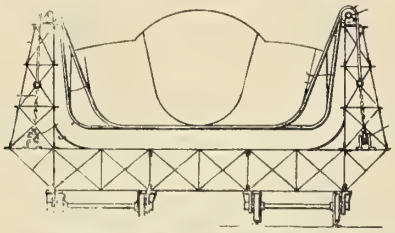


Claim.—1. The improvements in and relating to covers for vessels' hatchways and similar openings, comprising the combination of a hatchway, a cover thereto, a flexible waterproof strip having one of its edges attached to the edge of the cover, and means for clamping said waterproof strip tightly in a position overlapping the joining edges of the cover and hatchway.

2. The improvements in and relating to covers for vessels' hatchways and similar openings, comprising the combination of a hatchway, a cover thereto, a flexible waterproof strip, means for permanently fixing one edge of the said waterproof strip around the edge of the hatchway cover, and means for detachably clamping the other edge of said waterproof strip to the hatchway framing so that said strip overlaps the joining edges of the cover and hatchway. Seven claims.

722,436. TRUCK FOR TRANSPORT OF SHIPS, ETC. CARL V. SUPPAN, VIENNA, AND BELA SZENDI, BUDAPEST, AUSTRIA-HUNGARY.

Claim.—1. A vehicle for transporting vessels provided with a suitable body or superstructure, in combination with a cradle



in which a vessel is held in suspension in said superstructure, and composed of flexible bands adapted to automatically adjust themselves to the cross-sectional outline of such vessel. Three claims.

722,516. AIR SHIP. EDWARD P. JOHNSTON, HIGHLANDS, COLO. Fourteen claims.

722,572. SCREW PROPELLER. JOHN A. FEHLMAN, CROWNPOINT, IND.

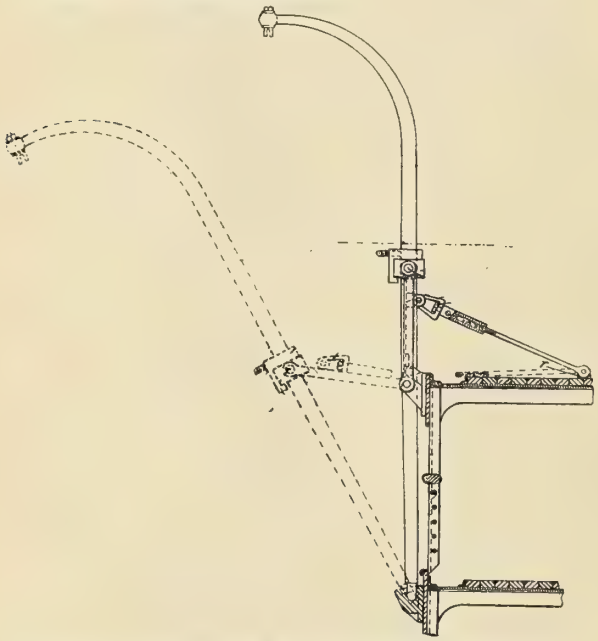
Claim.—In a screw propeller, in combination, a buoyant cylindrical body or shaft having conical heads, a longitudinally-concaved blade extending spirally around the shaft and making a plurality of turns between its ends, a tapered journal cap secured to each of the heads, a brace located in the cylindrical shaft near each end, a shaft entering into and secured in the journal cap and the brace, and journal bearings adapted to be secured to the hull of a vessel to receive the journal caps. One claim.

723,131. APPARATUS FOR REMOVING BARS AND SHOALS. EDSON BRACE, ST. LOUIS, MO.

Claim.—1. A device for dredging channels, comprising a frame, an engine mounted upon said frame, shafts carried at the ends of said frame, sprocket wheels slidably mounted upon said shafts, dredging chains operated by said sprocket wheels, said engine operating the device, and means for anchoring the device. Three claims.

723,333. BOAT-PROPELLING MECHANISM. JOSEPH M. STORY, OWOSSO, MICH. Two claims.

723,416. BOAT-LOWERING APPARATUS. ERNST O. SPETMANN, HAMBURG, GERMANY.



Claim.—1. An apparatus for lowering boats composed of a pivoted and axially-rotatable davit, a slide mounted on the same, and a pivoted arm connected to the slide. Two claims.

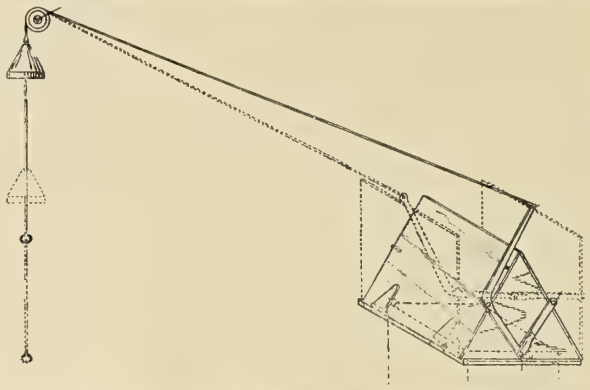
723,647. BUOYANT SEAT OR COUCH. HORACE S. CARLEY, HYDEPARK, MASS.

Claim.—1. A seat or couch consisting of a lifeboat having a continuous float of annular or similar form, a frame removably resting upon said float, and a pad or cushion resting upon said frame. Eight claims.

723,793. MEANS FOR OPERATING HATCHWAY DOORS. WM. R. WILCOX, SARATOGA, WYO.

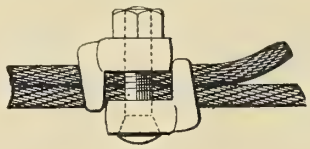
Claim.—1. In means for operating hatchway doors, the combination of a lever fulcrumed on one of the doors and having a downwardly-extending arm forming a toggle member, a link pivoted at one extremity to the opposite door, the opposite extremity of the link being pivoted to the downwardly-extending lever arm forming a toggle joint, and means connected with the free arm of the lever for manipulating the devices to open and close the doors.

2. In means for operating doors of the class described, the combination of a lever fulcrumed on one door, a link connected with the other door at one extremity and with one arm of the lever at the opposite extremity, and means connected with the other arm of the lever for opening the doors, said means comprising a flexible device, a guide over which said device passes, a counterweight connected with the opposite extremity of



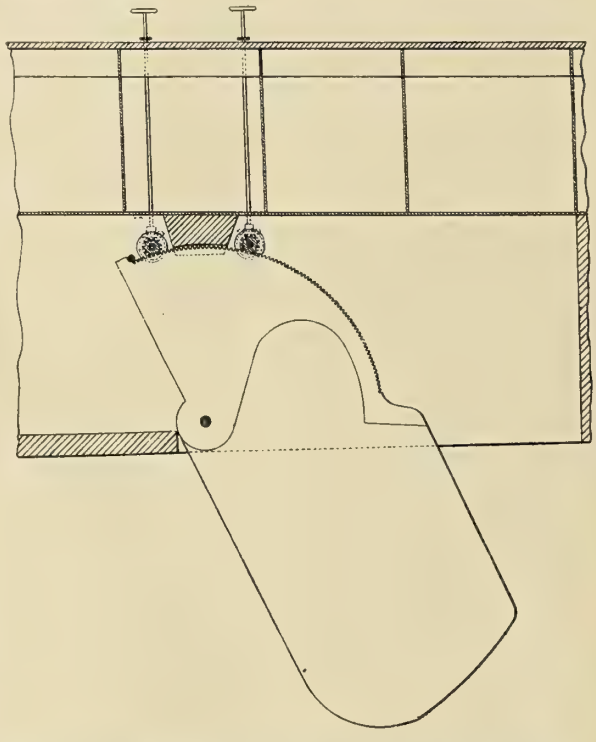
the flexible device, and a depending rigid device connected with the counterweight. Four claims.

723,862. GUY CLAMP. THOMAS E. HALLETT, CHICAGO, ILL.



Claim.—1. A clamp, comprising a pair of plates, each having at one end a pair of ears, the ears upon one plate extending longitudinally of those upon the other, each plate having a groove located between the ears and extending longitudinally of the plate, the said ears upon each plate being of such a length that when the clamp is assembled they will be opposite the ends of the companion plate, in combination with means for clamping the plates together. Four claims.

724,217. CENTERBOARD. ANSON P. STOKES, NEW YORK, N. Y.



Claim.—1. The combination with a centerboard of one or more strengthening-pieces secured on the same at its pivoted end, whereby the centerboard is to some extent balanced and a strong connection afforded with the shaft on which the same is mounted.

3. The combination with a centerboard, of a segmental rack on the pivoted or forward end, one or more pinions meshing with said rack, gearing for causing said pinions to rotate and means for actuating said gearing whereby the centerboard may be raised or lowered. Seven claims.